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A

TEXT-BOOK

OF

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BY

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FELLOW OF THE ROYAL COLLEGES OF SURGEONS OF IRELAND AND OF ENGLAND; PROFESSOR OF ANATOMY AND SURGERY OF THE UNIVERSITY OF DUBLIN; AND ONE OF THE SURGEONS OF THE JERVIS-STREET INFIRMARY, ETC., ETC.

WITH ADDITIONS,

BY

AN AMERICAN PHYSICIAN

WITH NUMEROUS ILLUSTRATIONS.

NEW YORK:
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389 BROADWAY.
1860.

THOMAS B. SMITH, STEREOTYPER
216 WILLIAM STREET, N. Y.

PREFACE.

In presenting a new Edition of the Dublin Dissector, or System of Practical Anatomy, I have to express my satisfaction at the favorable reception the former editions of this work have met with for many years.

Since its first appearance, in the year 1827, several editions have appeared, each containing some additions and improvements. The last having been for some time out of print, my Publishers have urgently requested me to prepare this edition, the completion of which has been unavoidably delayed by numerous other avocations.

Since the first appearance of this work numerous Manuals of Anatomy have been published in these as well as in other countries, some of which have been arranged very much after the same plan, others in a more systematic form.

In the present edition I have adhered very closely to that arrangement, which, being founded on practical experience, I originally adopted from a conviction of its being well suited to the improvement of the anatomical student: subsequent experience has confirmed this impression. The science, however, has of late years been so extended that the chief difficulty I have experienced has been to condense into a reasonable and convenient compass all the important parts of such a very extensive and varied subject. I have not abridged any portions of the former editions, but have added to, and altered most; I have also corrected many errors and inaccuracies which escaped my observation in the original. I have introduced much new matter, particularly on General or Structural Anatomy, also on the Nervous System and on the Organs of Sense. The whole work has been revised with much care, and may indeed be said to have been re-written; and I trust it will be found to contain a tolerably correct and complete, though condensed, view of the most important details of human descriptive anatomy.

I have also, in the present edition, illustrated the descriptions by numerous Engravings, according to the plan now so generally adopted by writers on anatomy, as well as on other descriptive or demonstrative sciences. For the selection, arrangement, and descriptions of the wood-cuts I am indebted to Dr. John Hill, late Demonstrator of Anatomy in the Park-street School of Medicine, who has devoted much time and trouble to this task. Many of the cuts are from original drawings by Mr. Du Noyer, and a considerable number are reduced copies, by that artist, of engravings in the standard works of the present day.

In the preparation of this work, the great object I have always held in view has been to direct the student in the manner best adapted to faciliate his inquiries; in the descriptive details, therefore, I have prefaced each with directions as to the best mode of displaying the anatomy of each region, and have then directed attention to those parts most useful in a practical, or most interesting in a physiological, point of view.

The many additions to the present work have increased it to such a size that I have deemed it advisable to divide the whole into two volumes or parts, —an arrangement which cannot, I think, be found in any way inconvenient, as each part contains distinct and independent subjects, and a copious Index of the entire is annexed to each volume.

I may take this opportunity of presenting my acknowledgments to numerous writers to whom I have referred, and from whom I have quoted in the following pages. I have also to offer my sincere thanks to my friends, Dr. Hill, for his exertions in respect to the wood-cuts, and Drs. Hatchell and King, for their trouble in revising and correcting the Press.

ROBERT HARRISON.

1, Hume-street, Dublin.

PREFACE TO THE AMERICAN EDITION.

The last edition of the Dublin Dissector, as prepared by Dr. Harrison, is much enlarged and improved, requiring but little alteration to render it a complete system of Anatomy for the use of students. Some valuable additions have been made under the supervision of Robert Watts, Jr., M. D., Professor of Anatomy in the College of Physicians and Surgeons of the University of the State of New York, and the work is now issued by the American publishers under the more appropriate title of, "A Text Book of Practical Anatomy."

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A

TEXT-BOOK OF PRACTICAL ANATOMY.

PART I.

OF THE MUSCLES, VISCERA, &c.

CHAPTER I.

DISSECTION OF THE EXTERNAL PARTS OF THE HEAD AND FACE.

SECTION I.

EXTERNAL PARTS OF THE HEAD.

The integuments (commonly called the scalp) covering the cranium are firm and dense, although when felt they give the sensation of being thin: the cuticle is delicate and scaly, but the cutis is very thick, and furnished with many sebaceous follicles. The subjacent cellular membrane contains granulated fat, and the bulbs of the hairs, which afterwards perforate the skin in an oblique direction. This tissue is condensed and lamellated, having somewhat a ligamentous structure, and adheres so intimately to the subjacent muscular and tendinous expansion, that the inexperienced student may find some difficulty in exposing the surface of the latter. Both this and the skin differ in structure in different situations; in the anterior third or fourth, or the frontal region, which is bald, and around which the hairs terminate in an abrupt line, as also around the ears, the cutis is delicate, and the cellular tissue is loose and contains less adeps; posteriorly they are more dense, vascular, and adherent, and perfect baldness seldom occurs; the hairs are stronger, they do not end abruptly, but continue soft and down-like for some distance along the neck: this part of the scalp is often found in the dead body congested with serous and sanguineous effusion, owing to the gravitation of the fluids after death.

Make an incision through the integuments along the median line, from the tuberosity of the occipital bone, as far forwards as the lower part of the forehead; from each extremity of this, make a transverse incision about three inches long; let the posterior one be parallel to the superior transverse ridge of the occipital bone, and the anterior one parallel, and about half an inch superior to the eyebrow; cautiously dissect off the integuments from the subjacent muscular and tendinous expansion, which is the occipito-frontalis. This muscle, like most of the superficial muscles of the face, is closely attached to the skin, which circumstance, added to the paleness and smallness of their fibres, renders their dissection somewhat difficult and tedious; there is no deep or dense fascia covering these muscles, as in other regions of the body. Most of the superficial muscles of the head and face, during life,

assist some of the organs of sense, and contribute to produce certain changes in the countenance, indicative of character or passion, and expressive of many diseases, tetanus, peritonitis, &c. In point of function, they may be considered as belonging to the class of mixed muscles, that is, they are in part voluntary, and in part involuntary: with the exception of the aponeurosis of the occipito-frontalis, the tendon of the orbicularis palpebrarum, and that of the corrugator supercilii, there is no perfect tendinous structure in the other muscles of this class.

The superficial muscles of the head are divided into those of the cranium and face. Those of the cranium are the occipito-frontalis, and the three common muscles of the ear: to these some add the corrugatores superciliorum; these, however, I prefer placing among the muscles of the face.

[The following table will give a comprehensive view of the muscles of the head and face, classed according to the part upon which they particularly act. There are six classes, including thirty-six pairs of muscles, and two single muscles, as follows:

FIRST CLASS, ONE MUSCLE.

MUSCLE OF THE SCALP.

Occipito-Frontalis.—*Vide p.* 20.

This by its palpebral insertion becomes a muscle of the eye, and by its nasal process, a muscle of the nose; it acts upon the scalp, eyebrow, lid, and nose.

SECOND CLASS, ELEVEN MUSCLES.

MUSCLES OF THE EAR.

These muscles are arranged in three groups, the first of three muscles moves the external ear, upon the head; the second of five muscles, moves the cartilages of the external ear, upon themselves; the third of three muscles moves the bones of the internal ear so as to render the membrana tympani, lax or tense.

First Group, three Muscles.

Superior Auris, or Attollens.	*Vide p.* 22.
Anterior Auris, or Attrahens,	
Posterior Auris, or Retrahens,	

Second Group, five Muscles.

Tragicus,	*Vide p.* 540.
Anti Tragicus,	
Helicis Major,	
Helicis Minor,	
Transversalis Auris,	

Third Group, three Muscles.

Stapedius,	*Vide p.* 547.
Tensor Tympani,	
Laxator Tympani,	" " 548.

THIRD CLASS, ELEVEN MUSCLES.

MUSCLES OF THE EYE AND ITS APPENDAGES.,

These muscles are found in two groups, the one of five muscles, acting upon the appendages of the eye, the other of six muscles, acting upon the ball of the eye.

First Group, five Muscles.

Occipito-frontalis, its palpebral insertion,	*Vide. p.* 20.
Corrugator Supercilii,	" " 24.
Levator Palpebræ Superioris,	" " 507.
Orbicularis Palpebrarum,	" " 23, 501.
Tensor Tarsi,	" " 24.

These muscles are all exterior to the orbit except the Levator Palpebræ Superioris which is within.

Second Group, six Muscles, all within the orbit.

Superior Rectus, or Levator oculi,	*Vide p.* 508.
Inferior Rectus, or Depressor oculi,	"
Internal Rectus, or Adductor oculi,	"
External Rectus, or Abductor oculi,	"
Obliquus Superior,	" " 511.
Obliquus Inferior,	" " 512.

FOURTH CLASS, FOUR MUSCLES.

MUSCLES OF THE NOSE.

These muscles are arranged in two groups, the one of two muscles proper to the nose; the other also of two muscles common to the nose and upper lip.

First Group, two Muscles, proper to the nose.

Pyramidalis Nasi, a process of the occipito-frontalis,	*Vide p.* 25.
Compressor Nasi,	"

Second Group, two Muscles, common to the nose and upper lip.

Levator Labii Superioris alæque nasi,	*Vide p.* 25.
Depressor Labii Superioris alæque nasi,	" " 26.

FIFTH CLASS, TEN MUSCLES.

MUSCLES OF THE MOUTH.

These are the muscles which act upon the different parts of the mouth, and are arranged in four groups, the first group includes but one muscle, which surrounds the whole mouth; the second embraces two muscles, which act upon the upper lip, (already enumerated, as common to it, and the nose ;) the third includes two muscles, which act upon the lower lip; and the fourth, five muscles, which act upon the angle of the mouth.

First Group, one Muscle—a single muscle.

Orbicularis Oris—*Vide p.* 26.

Second Group, two Muscles, common to the upper lip and nose.

Levator Labii Superioris alæque nasi,	*Vide p.* 25.
Depressor Labii Superioris alæque nasi,	" " 26.

Third Group, two muscles.

Levator Labii Inferioris,	*Vide. p.* 26.
Depressor Labii Inferioris,	" " 26.

Fourth Group, five Muscles.

Levator Anguli Oris,	*Vide p.* 25.
Depressor Anguli Oris,	" " 26.
Zygomaticus Major,	" " 25.
Zygomaticus Minor,	" " 25.
Buccinator,	" " 27.

In the case of the eyelids, the contraction of the orbicularis and consequent disfiguration is guarded against, by the cartilaginous tarsi placed along the adjoining margins of the lids; but in the case of the mouth, the contraction of the orbicularis and consequent disfiguration, is guarded against by the numerous muscles just mentioned, and which are inserted extensively into the

lips and their commissures or angles; this is demonstrated by the distortion of the mouth, in those cases where one side of the face is paralyzed.

SIXTH CLASS, FOUR MUSCLES.

MUSCLES OF MASTICATION.

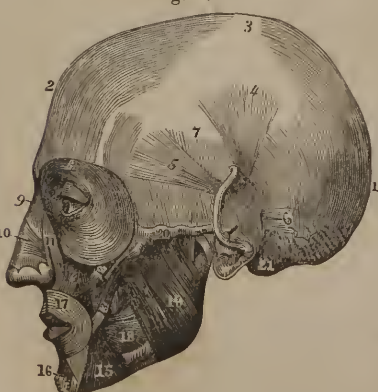
These muscles act upon the inferior maxillary bone, in raising the jaw and in mastication; they are variously situated, one being on the side of the face, one on the side of the head, and the other two beneath the base of the cranium, and within the inferior maxilla. They constitute one group.

Masseter,	*Vide p.* 31.
Temporalis,	" " 32.
Pterygoideus Internus,	" " 33.
Pterygoideus Externus,	" " 33.

Of all the muscles above enumerated, the orbicularis oris and the occipito-frontalis, are the only two, usually described as single muscles, all the rest being in pairs. The last mentioned group of muscles are those which are concerned in dislocations of the lower jaw.]

Occipito-Frontalis is the only muscle which properly belongs to the scalp; it is a thin, broad, digastric, or rather quadriceps muscle, fleshy at each extremity, aponeurotic in the centre. It is often so pale, weak, and thin, as to be difficult of dissection; the occipital portions are less adherent to the skin and more distinct than the frontal; its tendinous expansion is stronger and more apparent before and behind than superiorly or laterally. It *arises* on each side by tendinous and fleshy fibres, from the two external thirds of the superior transverse ridge of the occipital bone, and from the external and posterior part of the mastoid process; the fibres on each side ascend from behind forwards, and from without inwards, and soon terminate in one thin and broad tendon, which extends over the upper and lateral parts of the cranium.—This *epicranial aponeurosis* having arrived opposite the coronal suture, ends in two convex fleshy portions, broader and thicker, but paler, than the posterior extremities of the muscle; these anterior portions, which are thicker externally than internally, descend over the frontal bone, and are *inserted*, fleshy on each side, into the integument of the eyebrow, mixing with the fibres of the corrugator supercilii and orbicularis palpebrarum muscles: a small fleshy slip is often continued down along the nasal bones, and is attached to the internal angular process of the os frontis, and inferiorly to the nasal bones or cartilages: this slip is described by some as a distinct muscle, under the name of *pyramidalis nasi*, or fronto-nasalis. *Use.* The occipito-frontalis muscle can raise the eyebrows and integuments of the forehead into transverse wrinkles, draw the eyebrows a little outwards, and make tense the skin of the upper eyelids, and thus expose the eyeball, as in staring; it can also pull the scalp backwards; but if the eyebrows be depressed and fixed, this muscle can then (particularly in some persons) draw the scalp downwards and forwards. This mus-

Fig. 1.*



* The muscles of the head and face. 1. The occipital portion of the occipito frontalis muscle. 2. Its frontal portion. 3. The epicranial aponeurosis. 4. The superior auris,

cle is very closely connected to the scalp, particularly in front, but loosely to the cranium, it can thus move easily on the latter, carrying with it the former, which it also serves to support in apposition with the cranium, so as to prevent the skin slipping or yielding when any weight is pressed against the head.

Its origin is connected with the sterno-mastoid, the trapezius, and splenius muscles, and its insertion with those of the eyebrows. Some describe the occipito-frontalis, not as one, but as four distinct muscles, two on each side, under the names of the occipital and frontal muscles of each side, and consider the cranial aponeurosis as their common insertion.

Several vessels and nerves perforate this muscle, and ramify on its surface and in the integument, viz., anteriorly, the supra-orbital branches of the ophthalmic nerve and artery; laterally, the temporal and posterior auris arteries, with branches of the portio dura and inferior maxillary nerves; and posteriorly, the occipital arteries spread their tortuous branches upwards and forwards, accompanied by the occipital nerves, branches of the second cervical nerve. It covers from behind forwards, the occipital, temporal, parietal, and frontal bones, also the upper portion of each temporal aponeurosis, the corrugator supercilii muscle, and the supra-orbital nerves and vessels. The cranial or epicranial aponeurosis is composed of tendinous fibres which are distinct, glistening, and parallel behind, but anteriorly, superiorly, and laterally, become weak, grayish, and interlaced like cellular tissue, and frequently deficient in spots.

The integuments in this region are highly organized, being supplied with numerous nerves and vessels; these are derived from different and distant sources, and are chiefly destined to nourish the hair bulbs in the cellular tissue: in the line of the sutures they have frequent inosculations with the vessels of the diploe, and of the dura mater. This high organization of the scalp is not only of anatomical but of practical importance, as it serves to explain many of the *pathological* phenomena which are of ordinary occurrence in this region; thus, it is frequently the seat of encysted tumors, horny growths, &c.; these often appear to arise in the sebaceous follicles, the ducts of which have become obstructed from irritation or injury; a vitiated secretion then accumulates in the sac, which sometimes becomes circularly enlarged, and at others the contents slowly escaping from the ducts, and hardening, assume horny and various other appearances. The scalp is a common seat of erysipelas, both idiopathic and symptomatic. Injuries of it are of very frequent occurrence, and are more serious than those of the same extent in other situations. Incised wounds bleed more freely; punctured wounds are very frequently followed by high inflammatory symptoms, local and general, in consequence of matter being confined under the tense epicranial aponeurosis, which, in such cases, will require free division. The compact density of the cellular tissue explains the hard rim which surrounds the ecchymosis, the effect of contusion.

In the fœtus the scalp is very thin, and the aponeurosis is loosely attached to the pericranium by reticular membrane; this, and not the subcutaneous cellular tissue, is the seat of those large ecchymoses so commonly seen after parturition, and which in general are quickly removed by the absorbent system: at this age, too, the pericranium is very vascular, and except along the

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or attollens aurem. 5. The anterior auris. or attrahens aurem. 6. The posterior auris, or retrahens aurem. 7. The temporal aponeurosis. 8. The orbicularis palpebrarum, which conceals the corrugator supercilii and tensor tarsi. 9. The pyramidalis nasi. 10. The compressor nasi. 11. The levator labii superioris alæque nasi. 12. The zygomaticus minor. 13. The zygomaticus major. 14. The levator labii superioris proprius; a part of the levator anguli oris is seen between the muscles 12 and 13. 16. The depressor labii inferioris. 17. The orbicularis oris. 18. The buccinator. 19. The masseter. 20. The zygomatic arch. 21. The mastoid process.

sutures is easily raised from the bones, numerous red dots indicating the ruptured bloodvessels.

The common muscles of the ear are three in number, viz., superior, anterior, and posterior auris:

Superior Auris, or Attollens Aurem, is a small, thin, triangular muscle. situated on the temple and above the ear, *arising* broad and tendinous from the cranial aponeurosis, where it covers the temporal fascia on the side of the cranium, just above the external ear; the fibres descend converging, become fleshy, and are *inserted* into the upper and anterior part of the cartilage of the ear. *Use,* to raise the cartilage, and deepen the meatus of the ear, also to make tense the epicranial fascia. This muscle is between the skin and temporal fascia; its anterior edge is confounded with the following muscle.

Anterior Auris, or Attrahens Aurem, is connected with the last, is of the same form, but smaller, and often indistinct; it *arises* from the posterior part of the zygomatic process, and from the cranial aponeurosis, passes backwards and downwards, and is *inserted* into the anterior part of the helix. *Use,* to draw the external ear forwards and upwards. This muscle is superficial, and lies on the temporal fascia, vessels, and nerves; its lower edge is lost in the cellular tissue.

Posterior Auris, or Retrahens Aurem, often consists of two or three distinct fasciculi, it is the strongest of these auricular muscles; it has no connection to the epicranial fascia, but *arises* from the mastoid process above the sterno-mastoid muscle, passes forwards, and is *inserted* into the back part of the concha. *Use,* to enlarge the meatus of the ear and direct it backwards. This muscle is covered only by the skin; it lies upon the temporal bone.

In addition to these muscles, which move the external ear, there are several small muscles attached to different parts of the cartilages, which serve to alter their form, and expand their cavities; these muscles, as also those in the tympanum, shall be described hereafter in the dissection of the organ of hearing.*

SECTION II.

DISSECTION OF THE EXTERNAL PARTS OF THE FACE.

The muscles of the *face* require careful dissection; they are delicate, and often very pale; they may be classed into the superficial and deep: the former into those of the eyelids, nose, and mouth, being the dilators and constrictors of these openings; the latter into those of the lower jaw and palate. Make an incision around the base of the orbit, through the skin, which is here very fine, and closely adhering to the fibres of the orbicularis muscle; next make a perpendicular incision, along the middle line of the nose, to the centre of the upper lip, continue this in a semicircular manner round the angle of the mouth to the middle of the lower lip, and thence to the chin, and lastly from the chin to the angle of the jaw; reflect the integuments cautiously from the eyelids and side of the face, as far back as the ear, avoiding the slender muscular fibres which adhere to the skin, and the vessels and nerves which will be exposed in this dissection.

The integuments of the face are generally soft, delicate, and highly organized with vessels, nerves, and follicles; the vascularity is eminent in the lips

* Previous to. or immediately after dissecting the muscles of the face, the student should examine the brain, the description of which organ will be found at the head of the nervous system.

and cheeks; hair, soft and downy, covers the greater portion, particularly in man; in the latter also the beard and whiskers, which are of variable extent and strength, require a corresponding organization in the cellular tissue: in the eyelids, the latter is loose and reticular, always free from adeps, but prone to serous infiltration; both skin and cellular tissue are more dense in the median line than laterally, especially on the nose and lip: adipose substance surrounds most of the muscles and abounds in the young, and at all ages, between the masseter and buccinator muscles.

The superficial muscles of the face may be considered as thirty-three in number, that is, sixteen pair and one azygos, and are arranged as follows:

Three pair belong to the *palpebræ*, viz., orbicularis palpebrarum, tensor tarsi, and corrugator supercilii, (the levator palpebræ is deep seated in the orbit, and is arranged among the muscles of that region).

Four pair belong to the *nose*, viz., pyramidalis nasi, levator labii superioris alæque nasi, compressor and depressor naris.

Three pair belong to the *upper lip*, viz., levator labii superioris, levator anguli oris, and depressor labii superioris.

Three pair belong to the *lower lip*, viz., depressor anguli oris, depressor labii inferioris, and levator labii inferioris.

Three pair belong to the *mouth*, viz., zygomaticus major, minor, and buccinator, and one azygos, the orbicularis oris; writers vary this arrangement, but no material difference exists.

ORBICULARIS PALPEBRARUM, or SPHINCTER OCULI, broad and thin, somewhat oval, in some subjects very pale and indistinct, in others strong and well marked, it adheres to the skin, surrounds the base of the orbit, covers the eyelids, and occupies a great portion of the face; it *arises* by several fleshy fibres from the internal angular process of the os frontis, and from the upper edge of a small horizontal tendon (which *tendon*, TENDO OCULI, or TENDO PALPEBRARUM, nearly one quarter of an inch in length, is *inserted* internally into the upper end of the nasal process of the superior maxillary bone, thence passes outwards and backwards to the internal commissure of the eyelids, where it forks into two slips which inclose the caruncula lachrymalis, and are *inserted* each into the tarsal cartilage, and the lachrymal duct); the fleshy fibres then proceed in curves, upwards and outwards along the upper edge of the orbit, the eyelid and tarsal cartilage, as far as the temple and external commissure of the eyelids; thence the fibres curve in a similar manner along the inferior eyelid and edge of the orbit to the internal canthus, where they are *inserted* into the nasal process of the superior maxilla, into the inferior edge of the horizontal tendon, and into the inner third of the lower edge of the orbit. *Use*, to close the eyelids, chiefly by depressing the superior, the levator muscle of which it directly opposes: it also serves to press the tears inwards towards the puncta lachrymalia; the superior orbital fibres can depress the eyebrow and aid the corrugator supercilii in drawing it, as well as the eyelids, inwards, and oppose the occipito-frontalis and shade the eye; the inferior fibres can raise the cheek, raise and draw the lower eyelid inwards, and compress the lachrymal sac, which they cover. In sleep it is principally relaxed, and the eye is covered chiefly by the descent of the upper palpebra, its elevator muscle being also relaxed: when awake its contraction covers the globe, not only by bringing down the upper, but also by elevating the lower eyelid, hence the "equator oculi," the line formed by the approximated tarsi, is lower during real than in feigned sleep; in the former, also, the cornea is seldom entirely covered, as it always is in the latter.

This muscle is covered by and adheres to the skin; superiorly it overlaps and intermixes with the occipito-frontalis, and covers the corrugator supercilii, the temporal fascia, the frontal vessels and nerves, the tarsal cartilage and ligament, and the levator palpebræ superioris; inferiorly it intermixes with the

muscles of the cheek and lips, and sometimes with the platysma myoides, it covers the malar bone, the inferior tarsus and its ligament, the origin of the levator anguli oris, levator labii superioris, and the infra-orbital vessels and nerves. The external or *orbital* fibres of this muscle are strong and red, and run circularly round the base of the orbit; the middle or *palpebral* fibres are pale, thin, and scattered, and are contained in the eyelids; the internal or *ciliary* portion is a thick but pale fasciculus, situated under the ciliæ, at the edge of each eyelid. The palpebral and ciliary portions adhere more closely to the skin, and present an elliptical appearance, as the fibres from the upper and lower eyelid intersect each other at the outer canthus, and adhere to the ligament of the external commissure. The horizontal tendon of this muscle passes across the lachrymal sac a little above its centre, and is a little twisted; a strong aponeurosis derived from its upper and lower edge, covers all the anterior surface of the sac, and adheres to the margins of the bony gutter, in which it is lodged, where it becomes continuous with the periosteum. This tendon can be seen or felt through the integuments during life, particularly when the muscle is in action, or when the eyelids are drawn towards the temple.

Both in structure and function this muscle belongs to the mixed class; the external, circular, or orbital fibres are red, strong, and voluntary, and act very powerfully, as when we endeavor to screen the eye from too bright a light, while the inner portions of the muscle are relaxed, or only in slight action, whereas these latter fibres are weak, pale, and scattered, and essentially involuntary, and act in winking, while the orbital fibres are relaxed; during sleep, also, these fibres, like other sphincters, are in a state of gentle or tonic contractility. It sympathizes with the eye in a remarkable and most useful manner; it possesses great irritability, particularly in children; in purulent and strumous ophthalmia it is frequently spasmodically contracted, and totally prevents the eye being seen; this affection is somewhat analogous to the spasmodic constriction of the sphincter ani muscle.

In the operation of opening the lachrymal sac, the incision should commence immediately below this tendon, so as to avoid injuring it, and be carried obliquely downwards and outwards, to the extent of about half an inch.

Separate the orbicularis from the occipito-frontalis over the internal half of the superciliary arch, the tensor tarsi and the corrugator supercilii muscles will be exposed.

TENSOR TARSI *arises* tendinous from the posterior edge of the os unguis, where it joins the os planum, passes forwards between the conjunctiva and the expansion of the tendo oculi which covers the lachrymal sac, divides into two portions, which are inserted into the lachrymal ducts, along which the fibres extend, nearly as far as the puncta. *Use*, to draw the puncta and eyelids into close contact with the eye, also to press the puncta towards the nose, to compress the lachrymal sac, and to force out the secretion from the follicles of the caruncula lachrymalis. This muscle is also named HORNER's muscle, from its discoverer; it will be better seen if the two tarsi be divided about their middle, and their inner portions turned towards the nose without injuring the tendo oculi.

CORRUGATOR SUPERCILII *arises* fleshy and tendinous from the internal angular process of the os frontis, passes upwards and outwards, and is *inserted* into the middle of the eyebrow, mixing with the orbicularis and occipito-frontalis muscles. *Use*, to depress and approximate the eyebrows, throwing the skin of the forehead into vertical wrinkles, as in the act of frowning; this pair of muscles is voluntary, but they cannot act separately; they directly oppose the occipito-frontalis and shade the eye. They are covered by the orbicularis and occipito-frontalis, and lie on the os frontis and on the frontal nerve and vessels.

Pyramidalis Nasi, superficial, long, thin, often wanting, *arises* from the occipito-frontalis, descends close to its fellow between the brows, covering the nasal bones and sutures, becomes broad and aponeurotic, and is *inserted* into the compressor nasi muscle. *Use*, it raises the skin covering the ossa nasi, when the occipito-frontalis is in action, but if the latter be relaxed, it can then draw down the inner end of the eyebrow.

Compressor Nasi is thin and triangular, placed on the side of the nose, between the skin and the cartilage; it *arises* from the inner side of the canine fossa, in the superior maxilla; the fibres pass forwards, expanding over the ala nasi, and are *inserted* by a thin aponeurosis into the dorsum of the nose, joining some fibres from the opposite side. *Use*, to press the ala towards the septum, or to draw it from it, so that it may alternately enlarge or diminish the anterior naris; its action will partly depend on the form of the cartilage; if convex, it may compress; if concave it may expand the ala nasi; in difficult inspiration it appears in a state of increased action, and is then a dilator more than a compressor, at the same time raising the upper lip, but when inhaling odors it alternately expands and compresses the ala; in tetanus it permanently dilates it. The insertion of this muscle is connected with the occipito-frontalis, and pyramidalis, and its origin with the following, which partly covers it.

Levator Labii Superioris Alæque Nasi is long, thin, and triangular, placed on the side of the nose, between the orbit and the upper lip; it *arises* by two origins; first, from the upper extremity of the nasal process of the superior maxilla; second, broad, from the edge of the orbit, above the infra-orbital hole; the fibres descend and converge a little, and are *inserted* into the ala nasi, and into the upper lip and orbicularis oris muscle: its name denotes its *use*. The superior and orbital origins of this muscle are covered by the orbicularis palpebrarum; the inferior portion is superficial; the angular vein and artery separate its origins: the orbital head covers the infra-orbital nerve and vessels, the levator anguli, and some of the orbicularis oris muscles.*

Zygomaticus Minor is very small, and sometimes wanting; it *arises* from the upper part of the malar bone, passes downwards and forwards, and is *inserted* into the upper lip near the commissure, uniting with the other muscles which are inserted there. *Use*, to draw the angle of the mouth upwards and outwards, as in smiling; it lies superior and parallel to the major, between which, and the levator labii, it is inserted.

Zygomaticus Major is long and narrow, and inferior to the last; *arises* tendinous and fleshy from the lower part of the malar bone, near the zygomatic suture: it descends obliquely forwards, and is *inserted* into the angle of the mouth. *Use*, to draw the corner of the mouth upwards and backwards. The zygomatic muscles are partly concealed at their origin by the orbicularis palpebrarum; their insertion intermingles with the levator, depressor anguli, and orbicularis oris muscles; they lie on the malar bone, and cross the masseter and buccinator muscles, also the labial vein and artery, and they run superficial and superior to the duct of the parotid gland; they are imbedded in much soft adipose substance.

Levator Anguli Oris (musculus caninus) is situated about the middle of the face, behind and a little external to the orbital portion of the levator labii superioris alæque nasi, or the levator labii of some; *arises* from the canine fossa

* The external or orbital head of this muscle is described by most writers as a distinct muscle, and has been enumerated by me as such; it is called *Levator Labii Superioris*: as, however, it will be found on dissection to be inseparably connected with the levator labii alæque nasi, I prefer describing it as part of the outer head of that muscle; in like manner I have united the *depressor labii superioris* or *incisor*, and the *depressor naris*, which are by some described as distinct muscles; much variety will be found in the number and structure of the muscles in the nasal and labial regions; this accounts for the different expression of the corresponding features during life, as also for the different descriptions given of these muscles by different authors.

in the superior maxillary bone, immediately below the infra-orbital foramen, and above the alveolus of the first molar tooth; it descends obliquely forwards and outwards, and is *inserted* narrow into the commissure of the lips, and into the orbicularis oris; its name denotes its *use*. This muscle is covered by the orbicularis palpebrarum, levator labii superioris alæque nasi, zygomatic muscles, and by a quantity of soft adeps, also by the infra-orbital nerve and vessels, which ramify upon its surface and separate it from the orbital portion of the levator labii alæque nasi: it lies on the superior maxilla, the buccinator muscle, and the mucous membrane of the mouth.

Depressor Labii Superioris Alæque Nasi, a small flat muscle, very variable as to size and structure, exposed by everting the upper lip, and raising the mucous membrane on the side of its frænum; it *arises* from the myrtiform fossa in front of the alveoli of the canine and incisor teeth of the superior maxilla, ascends obliquely forwards, and is *inserted* into the teguments of the upper lip and into the fibro-cartilage of the septum and ala nasi. *Use*, to press the lip against the anterior teeth, and even to draw it under these, also to depress the septum and ala nasi. It is covered by the levator labii, orbicularis oris, and mucous membrane, and it lies upon the bone.

Depressor Anguli, vel Triangularis Oris, flat and triangular, apex above, situated at the lower part of the face; *arises* broad and fleshy from the external oblique line on the outer side of the lower jaw, which extends from the anterior edge of the masseter muscle to the mental foramen; the fibres ascend converging, and are *inserted* narrow into the commissure of the lips, where the fibres are continuous or mingled with the orbicularis, zygomatic, and levator anguli muscles: its name denotes its *use*. This muscle is covered by the skin, some of its fibres are continuous with those of the platysma myoides; it overlaps the buccinator and the following muscle. The facial artery bounds its external edge, and separates it from the masseter.

Depressor Labii Inferioris, vel Quadratus Menti, broad and somewhat square, *arises* from the side and front of the lower maxilla, just above its basis, internal to the last, and continues as far forwards as the middle line; the fleshy fibres, intermixed with fat, ascend a little inwards, decussating with some of the opposite muscle, and are *inserted* into half of the lower lip and into the orbicularis oris; its name denotes its *use*. This muscle is covered by the skin, and externally by the depressor anguli oris; it lies on the bone, the mental nerves and vessels, orbicularis oris muscle, and mucous membrane: by separating this from the last muscle, the mental nerve and vessels are exposed; the fibres are parallel, and many are continuous with those of the platysma; this muscle is difficult to dissect, its inner fibres being pale and intermixed with fat, it is not unlike the structure of the tongue: it conceals the following muscle:

Levator Labii Inferioris, vel Menti, is best exposed by turning down the upper lip, and raising the mucous membrane by the side of the frænum; *arises* from the alveoli of the incisor teeth of the lower maxilla, by the side of the symphysis; the fibres diverge as they descend obliquely forwards between the mucous membrane and the depressor labii inferioris; *inserted* into the integument of the chin. *Use*, to elevate the chin and lower lip: this muscle is analogous to the depressor of the upper lip. It assists in forming the prominence of the chin.

Orbicularis, vel Sphincter Oris, surrounds the opening of the mouth; consists of two fleshy fasciculi, one for either lip, placed between the skin and mucous membrane, and constituting the chief thickness of the lip; these fasciculi decussate each other at the commissures, and intermix with all the dilating muscles inserted there. *Use*, to approximate the lips and regulate their motions in the acts of speaking and breathing, and to oppose the actions of the several muscles which are inserted into the commissures; it can also

close the lips with different degrees of force, as in the process of suction, mastication, and deglutition. This muscle has no bony attachment; its fibres are blended with fat, particularly on their cutaneous surface; internally they are more smooth and distinct; they adhere most closely to the skin, and throw it into numerous minute rugæ when they contract.

Buccinator is broad, thin, and somewhat square; situated between the two alveolar arches, it forms the inner side of the cheek, and the lateral boundary of the mouth, and lies close to the mucous membrane of the latter; *arises* posteriorly from the two last alveoli of the superior maxilla, as far back as the pterygoid process, from the external surface of the posterior alveoli of the lower maxilla, as far back as the coronoid process, and from a strong aponeurosis, named the pterygo or *intermaxillary ligament* (which extends from the extremity of the internal pterygoid plate and tuberosity of the superior maxillary bone, to the root of the coronoid process, and which affords attachment to the superior constrictor of the pharynx posteriorly and to the buccinator anteriorly.) From these three origins the fibres pass forwards, at first horizontally, but then converge, and the superior and inferior decussate, and are *inserted* into the commissure of the lips, where they intermix with those of the orbicularis and of the other muscles at the angle of the mouth. *Use*, to press the cheek against the teeth, so as to bruise and push the food between them, and to diminish the cavity of the mouth, as in mastication and deglutition; it is also much engaged in the articulation of certain expressions, as well as in filling wind instruments; it can also retract the commissure of the lips. The buccinator is covered, even in thin subjects, by a considerable quantity of fat, which separates it from the coronoid process of the lower maxilla, and from the insertion of the temporal muscle (this fat extends in the form of large, soft, round masses beneath the masseter muscle); it is also covered by the zygomatic, the depressor anguli oris and platysma muscles, and by the facial vessels; several branches of the facial artery and vein, and of the seventh and fifth pairs of nerves, ramify on its surface; it lies on the mucous membrane and on a number of small round mucous glands called buccal; it is perforated near its superior posterior third by the duct of the parotid gland, opposite the lower edge of the second or third superior molar tooth, a strong fascia is continued from the outer coat of this vessel over the muscle.

The group of superficial muscles now described present peculiarities, both as to structure and function, when contrasted with those in other regions; the orbicularis oris has no bony attachment; all the other facial muscles have one extremity only inserted into bone or periosteum, and that in a very feeble manner, the other being attached to skin or subcutaneous or submucous tissue, or to some other muscle; they have little or no tendon in their structure; their fibres are weak, soft, and loosely connected to each other, without investing sheath or fascia; their general development is very variable, and bears no ratio in strength and color to that of the general voluntary muscular system. They present many characters in common with the mixed class; the will has not perfect control over them, and they occasionally assist in respiration without its influence; nervous and mental emotions, health and disease, pleasure and pain, affect them in a well known and remarkable manner; by their habitual action they cause certain folds or lines in the skin, more or less permanent, which give rise to peculiar expressions of the countenance, indicative of corresponding feeling and passion, and thus lay the foundation for the study of physiognomy. A cheerful, joyous state of mind being for the most part denoted by an expansion and elevation of all the features, effected by the combined actions of the occipito-frontalis and of the elevators of the lips, and of their commissure; while in the opposite condition, that of sadness, sorrow, or deep thought, the countenance is rather elongated, and the features depressed by the corrugators of the eyebrows, and by the depressors of the

lips and commissure, aided also by the platysma myoides, which latter, though arranged among the cervical muscles, yet plainly intermingles by many fibres with those of the lips and cheeks, and must therefore exert considerable influence in the motions of these parts, as also in the expressions of the countenance consequent thereon.

The deep muscles of the face, which are connected with the lower maxilla, and which are employed in the process of mastication, are the masseter, temporal, internal, and external pterygoid of each side: previous to dissecting these, the student should examine the situation and connections of the parotid gland, the chief of the salivary glands. There are six *salivary glands*, three on each side, the parotid, submaxillary, and sublingual.

The salivary glands, together with the lachrymal, mammary, and pancreas, are commonly called conglomerate glands, in contradistinction to the absorbent, or lymphatic, or conglobate glands; this term, however, is by no means distinct or definite, for other glands, viz., the liver and kidney, are equally conglomerate, though not so obviously such. The general arrangement of the glandular system we propose, is into two orders, the Absorbent and Secreting; the *absorbent*, or *lymphatic*, or *conglobate*, will be noticed hereafter: the *secreting* order may be divided into two classes, viz., the simple and the complex; the *simple* are the numerous glands which are attached very generally to the mucous membranes; the *compound* secreting or conglomerate glands are the lachrymal, salivary, mammary, pancreas, liver, kidney, prostate, and testis. There is no evidence for considering the pinæal, pituitory, thyroid, thymus, or supra-renal bodies, or the spleen and ovaries, as true glands.

The salivary glands, as well as the lachrymal, the mammary, and the pancreas, all correspond in certain characters, in which, also, they differ from other secreting glands: they are all symmetrical, except the pancreas, which, however, is attached to the digestive organs, the chief apparatus of organic life, one in which no symmetry is observed: they are of a pale gray color, with a slight reddish tint; the virgin mammary gland is almost white; they have no perfect capsule, except the mammary, and that, though perfect, is very thin and loose; their form and size are not accurately defined, two or more being sometimes connected; they are very irregular in these respects; their texture is loose, that is, they consist of lobes which are composed of irregularly shaped lobules, these latter are separable into granules, each of which is formed by a final dilatation, or cœcal pouch of the minute ramification of an excretory duct, these ducts unite into larger or lobular ducts, and these finally unite into one or more excretory ducts; the lobules are but loosely connected by cellular tissue and vessels, while the granules themselves are very firm and compact. They are all well supplied with nutrient vessels; the arteries ramify minutely before they enter them, which they do at all parts of their surface, and not at any particular fissures, as in the liver and kidney; the transit of the carotid and facial arteries through the parotid and submaxillary glands is not an exception to this statement. The veins in like manner escape at different parts, and enter the neighboring vessels. Their excretory ducts in some unite into one vessel, which proceeds to its destination, but in others, as in the lachrymal, mammary, and sublingual, they continue separate to the surface. In no case is there any perfect reservoir to delay or retain the secretion, as in the case of the liver and the gall bladder, the kidney and the vesica; the lachrymal sac cannot be considered as such, and the ampullæ in the mammary gland but imperfectly so. They are largely supplied with nerves, which, except the filaments of the sympathetic, accompanying the vessels, are derived from the spinal and cerebral system; the pancreas is an exception to this rule: not only cellular tissue in abundance, but even adipose, enter into their composition; they are in close connection with the lymphatic or absorbent system, numerous lymphatic vessels pervade

hem, and lymphatic glands are in their close vicinity, and occasionally even mbedded in their substance. In many of these characters, the salivary glands form a remarkable contrast with the other complex secreting glands, which will more fully appear when the latter come under our notice. All the secreting glands, simple as well as compound, are subject to many diseases; these will be noticed in the account of the individual glands.

The Parotid Gland is the largest of these conglomerate glands, it derives its name from its proximity to the ear; it is exposed by dissecting off the integuments and some fibres of the platysma, also a dense fascia which covers and adheres to it; this fascia is continued from that of the neck, spreads over the gland, is closely connected to the cartilaginous part of the meatus auditorius, and sends numerous processes into the gland in every direction, which serve to separate its lobules, and to conduct the different vessels through its substance. The parotid gland is not of any regular figure, by some it is considered pyramidal, the apex above, the base directed outwards and downwards; by others (the upper end being more developed), an irregular square; as such we shall consider it, and, of course as presenting two surfaces, a superficial and a deep, and four margins, a superior, inferior, anterior, and posterior: it occupies, together with some other important parts, that deep excavation on the side of the face between the lower jaw and the auditory meatus, it also extends into the small region of the neck, named the posterior digastric space; it is bounded above by the zygoma, below by a line drawn from the angle of the jaw to the mastoid process, posteriorly by the meatus auditorius, the mastoid process, and sterno-mastoid muscle, and anteriorly by the masseter muscle, the posterior third of which it overlaps. The external surface is pale, flat, or slightly convex, in this respect, however, differing in different persons, as it also does in superficial extent; probably the absence of a regular capsule may in some measure account for this diversity; the anterior and inferior margins are the least defined, are irregular in their extent, in some they considerably exceed the ordinary bounds; the superior border is limited by the attachment of the fascia to the zygoma, and the posterior is resisted by the meatus of the ear, and by the sterno-mastoid muscle.

The connections of the deep surface may be examined after the course of the excretory duct, and of the several vessels and nerves which pass through the gland, shall have been exposed. The *Parotid* or *Steno's duct arises* from its anterior superior border, and is formed by the union of numerous small vessels, which issue, each, from one of the granulations of the gland; it passes forwards over the masseter muscle, about an inch below the zygoma, parallel to a line drawn from the tube of the ear to midway between the commissure of the lips and the root of the nose; it winds round the anterior edge of the masseter, beneath the zygomatic muscles and through a quantity of soft adeps, pierces the buccinator, and opens through the mucous membrane of the mouth by a very small hole, without any papilla or projection, opposite the second or third superior molar tooth, about half an inch from the junction of the cheek with the gum. Between the duct and the zygoma, a small, smooth, glandular mass is frequently found, it appears like a detached lobe of the parotid, and is named the *socia parotidis;* from the lower and anterior part of this process, a small duct proceeds, which after a short course unites with the duct of Steno; in some this duct opens distinctly into the mouth. The transverse artery of the face, and several branches of the facial nerve, accompany this vessel, and in general the artery is superior to it, while the nerves wind around it. This duct appears much larger than its calibre really is; it is formed of two coats, the external white, fibrous, and dense, commences beyond the anterior edge of the gland, and ends at the buccinator muscle; and the internal, a fine, delicate, mucous membrane, is

continuous with that lining the mouth: the canal is larger at the commencement and outside the buccinator than in the intervening space, or at the orifice in the mouth.

The parts which pass through this gland are the external carotid artery and several of its branches, with their accompanying veins, and branches of the inferior maxillary and cervical nerves, also the plexus of the portio dura, or facial nerve. The first or most superficial of these parts is the *ascendens colli nerve*, or the superficialis colli or auricularis, it enters the gland near its lower border, and is lost chiefly in communicating with the *portio dura;* this last named nerve escapes from the cranium by the stylo-mastoid foramen, enters the gland at its posterior inferior part, passes forwards and upwards through it, and forms in its substance the remarkable plexus, *parotidæan*, or *pes anserinus*, which crosses superficial to the external carotid artery, and then separates into its two great divisions, the superior and inferior; a small portion of the gland intervenes between it and the vessels. The branch of the inferior maxillary nerve which traverses the gland is the *temporo-auricular*, which will be found between the neck of the lower jaw and the meatus auditorius, about half an inch above, but much deeper than the portio dura, with which it communicates, and for a branch of which it is sometimes mistaken.

The *external carotid artery* will be found to enter the lower border of the gland, near its deep surface; as it ascends it is crossed by the portio dura, and becomes much more superficial, its posterior auricular branch borders the lower and back part of the gland, the temporal ascends through it, the internal maxillary is deeply imbedded in it in its course forwards and inwards, the transverse facial artery also traverses it in a direction forwards, it also gives off numerous branches to the granules of the gland and to the ear. The veins corresponding to these arteries also pass through this organ; the temporal and internal maxillary, by their confluence, which is superficial to the external carotid artery, and very rarely to the portio dura also, forms the *external jugular vein*, which descends through the gland and becomes superficial in the neck. Several lymphatic vessels and glands are connected with the parotid, particularly along its inferior border; generally one or two small glands may be found imbedded in its substance, in front of the meatus auditorious, just where its cartilage is deficient.

Now divide the parotid duct, raise off the gland from the masseter muscle, and from the ramus of the jaw, and observe its several deep-seated connections.

The deep or posterior surface of the gland is very irregular, it covers the posterior third of the masseter, also the ramus of the jaw behind which it sinks, and fills the deep excavation between this bone and the ear, envelopes the styloid process of the temporal bone and the muscles which arise from it, and touches the internal carotid artery, jugular vein, and the large nerves connected with these vessels; it also fills the posterior part of the glenoid cavity in the temporal bone, and adheres to the capsular ligament of the maxilla, inferiorly it is wedged in between the internal pterygoid, digastric, and styloid muscles.

The styloid process is in some cases so involved in this gland as to appear to divide it into a superficial and a deep lobe, the latter will then be deeper than this process and in close connection with the great cervical nerves and vessels: a portion of the parotid will also be found to accompany the internal maxillary artery between the ramus of the jaw and its internal lateral ligament; this touches the inferior maxillary nerve, and in many instances extends into the fatty space between the two pterygoid muscles, where it swells out to a considerable size, so as to appear like a distinct lobe connected to the body of the gland by a narrow neck.

The parotid gland receives its nutrient vessels from the external carotid

artery and its branches; its nerves are derived from the auricular branch of the fifth pair, from the cervical plexus, and from the sympathetic. The portio dura traverses it, but does not probably supply it, although some of its filaments can be traced to the fibrous coat of its ducts.

The parotid gland is composed of numerous small lobules, united together by cellular tissue, by branches of bloodvessels and nerves, and by the small roots of its excretory duct. A very small lobule can, by dissection and maceration, be divided into many smaller grains; it is probable that each minute granule is essentially a small cœcal pouch of a minute excretory duct; several of these latter coalesce to form the excretory duct.

The parotid gland is subject to several MORBID changes, viz., inflammation, or cynanche parotidæa, or parotitis, or mumps; abscess; hypertrophy, or scirrhous induration, which sometimes requires extirpation; scirrhus, ending in cancer; fistula, the effect of abscess or wound of the gland or duct; atrophy, or absorption; this latter condition is usually caused by tumors, lymphatic or encysted; these by degrees come to occupy the position of the gland and cause its absorption. Such tumors simulate the enlarged parotid, though essentially different; they admit of more easy extirpation, as they are usually surrounded by a capsule, and are not traversed by the adjacent nerves and vessels.

Next clean the masseter muscle and the temporal aponeurosis.

MASSETER.—The greater part of this muscle is superficial, it is thick and strong, covers the ramus and angle of the jaw, and consists of *two portions*, one anterior, which is the larger, the other posterior; these decussate each other; the *anterior arises* chiefly tendinous from the superior maxilla where it joins the malar bone, also from the inferior edge of the latter, the fibres pass downwards and backwards, and are *inserted* fleshy into the outer surface of the angle of the lower maxilla. The *posterior* or deep portion of the muscle *arises* chiefly fleshy from the edge of the malar bone and from the zygomatic arch, as far back as the glenoid cavity; the fibres descend, some vertically, others obliquely forwards, and are *inserted*, chiefly tendinous, into the external side of the angle and ramus of the jaw, as high as the coronoid process; thus the two layers of this muscle are contrasted both in the direction of their fasciculi, as well as in the relative position of their tendinous and fleshy fibres. *Use*, if both portions of both muscles act together, they will elevate the lower jaw; if the anterior portions only of opposite sides act together, they can carry the jaw forwards and upwards; and if the posterior alone, they can move it backwards and upwards; if the superficial layer of one side act alone it can rotate the chin to the opposite side, and if the deep layer only act it can rotate it to its own side. Thus the masseter muscles of opposite sides, by the alternate action of their different portions, are powerful agents in mastication; they not only cause the division of the food by the direct elevation and pressure of the lower maxilla against the upper, but they can also triturate it, by the great lateral motion of the jaw which their different laminæ are capable of exercising alternately. The masseter is covered by the skin, some fibres of the platysma and orbicularis palpebrarum, a portion of the parotid gland, and its excretory duct, by the transverse facial vessels and nerves, and by the zygomatic muscle. It lies on the ramus of the jaw, and conceals the insertion of the temporal, and the origin of the buccinator, from which it is separated by a great quantity of fat; the superficial layer covers the deep one, except a small portion of the latter near the articulation of the maxilla; strong tendinous septa pass from the surface of this muscle through its substance, and adhere to the ramus of the bone beneath.

The masseter, by its superficial layer, may assist in dislocating the lower jaw, if it suddenly contract when the chin is much depressed. This muscle, like the temporal, appears to be much under the influence of the nervous system and extremely irritable, it is very seldom in a state of paralysis, even

when the superficial muscles of the face are so; whereas in tetanus it is in a state of almost rigid contraction: in rigors also, or when exposed to much cold, these muscles evince their sympathy with the general system, the will loses all control over them, they act irregularly, and produce the "chattering of the teeth."

TEMPORALIS is concealed by the temporal aponeurosis, the zygoma, and the masseter, it fills the temporal fossa, is thin and broad above, thick and narrow below. The *aponeurosis* is white and glistening, very strong and tense, of a semicircular form, adhering by its superior convex border to the semicircular ridge on the side of the cranium, which extends from the external angular process of the frontal along the parietal, as far back as the mastoid process of the temporal bone, and by its inferior straight margin to the upper edge of the zygoma, and to the superior posterior edge of the malar bone. This fascia is thin above, the muscle appears through it; inferiorly it is thick and opaque; it consists of two laminæ which are very distinct inferiorly, some fat, vessels and nerves being interposed; the fibres composing the external layer run longitudinally, those of the internal irregularly. The temporal aponeurois confines the muscle in its place, and gives additional origin to its fibres. Separate the masseter from its superior attachment, divide with the saw the zygoma at either end, and elevate it together with the lower part of the temporal fascia; the temporal muscle will be thus exposed. It consists of two laminæ, the superficial is thin, but the deep layer is very thick; an aponeurosis or tendon is between these. It *arises* from all the side of the cranium beneath the semicircular ridge on the parietal bone, and from all the temporal fossa and fascia; the fibres therefore are attached internally to the parietal, frontal, and temporal bones, also to the sphenoid as low down as the crest at the root of its great wing, which crest separates the temporal from the zygomatic fossa; anteriorly to the malar bone, and externally to the inside of the temporal fascia, and to the zygomatic arch. The fleshy fibres all descend converging; the middle nearly vertical; the anterior with a little obliquity backwards; the posterior, which are very long, pass nearly horizontally forwards, over a smooth surface at the root of the zygoma, and the inferior fibres, which arise from the crest on the sphenoid bone, are very short, and pass transversely outwards.

Inserted by a strong tendon into the coronoid process of the inferior maxilla; it nearly surrounds that process, except on its outer side, and is continued along its forepart as far as the last molar tooth. *Use*, to raise the lower jaw when the whole muscle acts; the anterior fibres may also advance the jaw, and the posterior long fibres can draw it backwards, while the inferior transverse fibres, which are nearly parallel to the external pterygoid muscle, may assist in its lateral and rotary motions; this muscle, particularly its posterior portion, is the greatest security which the jaw possesses against dislocation, as it directly opposes the external pterygoid muscles which tend to advance the jaw, and to place its condyles on the zygomatic eminences. The temporal muscle is covered by the integuments, occipito-frontalis, superficial temporal vessels and nerves, temporal fascia, zygoma, masseter, orbicularis palpebrarum, and auricular muscles; it lies on the side of the cranium, and covers all the bones which compose the temporal fossa, also the deep temporal vessels, and part of the external pterygoid and buccinator muscles, from which it is separated by much fat.

Wounds of the temporal aponeurosis are often attended with serious effects, the severe pain and tension interfere with the action or extension of the muscle, the mouth can scarcely be opened, nor can mastication be performed without great difficulty; these symptoms simulate tetanus, from which, however, they may be distinguished by attention to the countenance and to the state of the muscles of the opposite side: suppuration beneath this fascia is

both troublesome and dangerous; injury to it should be avoided in arteriotomy. In vital powers this muscle is analogous to the masseter, it is largely supplied with nerves from the same source. Remove the temporal, masseter, and buccinator muscles, also the zygomatic arch, saw or break off, low down, the coronoid process, dissect away some fat, and the pterygoid muscles will be exposed, the dissection of which may be still further facilitated by dividing the side of the lower jaw in front of the insertion of the masseter, as the angle and ramus of the jaw can then be moved backwards and forwards.

Fig. 2.*

The pterygoid muscles are situated very deep behind the ramus of the lower jaw, they are two in number, internal and external, their names, however, only refer to their origins from the external pterygoid plate of the sphenoid bone, for neither are attached to the internal plate; that which is called external is nearer to the median line of the body, the internal is more superficial, and therefore first met with in dissection.

Pterygoideus Internus is strong, thick, and somewhat quadrangular, placed on the inner side of the ramus of the jaw, parallel and very similar to the superficial layer of the masseter muscle externally; it *arises* tendinous and fleshy from the inner side of the external pterygoid plate, and pterygoid process of the palate bone; it fills the greater part of the pterygoid fossa, descends obliquely outwards and backwards, and is *inserted* tendinous and fleshy into the inner side of the angle of the jaw, and into the rough surface above it. *Use*, if the muscles of opposite sides act together, to draw forwards and to elevate the jaw, thus co-operating with the superficial layers of the masseter muscles; if alternately, they can rotate it, each moving the jaw laterally, so as to turn it to the opposite side. This muscle is larger and longer than the external pterygoid, inferior and external to which it lies. Above, the tensor palati and superior constrictor, and below, the submaxillary gland are in contact with its internal surface: the ramus of the jaw is external to it, and separated from it by the dental nerve, the internal maxillary artery and its primary branches, which are protected from the pressure of the muscle by the internal lateral ligament of the jaw; the gustatory nerve crosses it in front: the lower and posterior extremity of this muscle is very superficial, lying between and in contact with the parotid and submaxillary glands: the upper extremity or origin is separated by the tendon of the tensor palati muscle from the internal pterygoid plate, it is concealed by, and lies deeper than that of the external pterygoid muscle.

Pterygoideus Externus is short and triangular, the base at the pterygoid process, the apex at the condyle, placed at the lower part of the temporal fossa; it *arises* broad and fleshy from the outer side of the external pterygoid plate, from the crest on the root of the great wing of the sphenoid (which divides the temporal from the zygomatic fossa), and from the back part of the tuberosity of the superior maxilla; the fibres pass outwards and backwards, horizontal, converging, and twisted, are *inserted* tendinous into the anterior and internal part of the neck of the lower jaw, into the interarticular cartilage and inferior synovial membrane. *Use*, when both muscles act, they draw forward the jaw, and at the same time the interarticular cartilages, which serve as movable or temporary sockets to prevent the condyles slipping off the zygomatic eminences, when the chin is advanced, or the mouth opened; if the muscle of one side only act, it will draw forward the condyle of that side, and turn the chin to the opposite, and therefore when both

* The internal and external pterygoid muscles. The zygomatic arch and a portion of the ramus of the lower jaw have been removed. 1. The internal pterygoid. 2. The sphenoidal portion of the external pterygoid. 3. Its pterygoid portion. 4. The condyle of the lower jaw.

muscles act alternately, they will become the principal agents in triturating or grinding the food. The external pterygoid muscle lies in a transverse direction beneath the base of the cranium, superior to the internal pterygoid, except at its origin; it is internal and inferior to the temporal muscle, and is also concealed by the masseter and the ramus of the jaw; superiorly it is in contact with the sphenoid bone, posteriorly with a number of veins and with the inferior maxillary nerve at its exit from the foramen ovale, while anteriorly and inferiorly it is in contact with much adipose matter, and with the principal branches of the internal maxillary artery and inferior maxillary nerve. As the external and internal pterygoid muscles arise so near each other, and thence pass in different directions to their insertions, the external going transversely, and the internal descending, they leave between them a triangular space, which contains a quantity of fat, a small portion of the parotid gland, the internal maxillary artery and vein, and the dental and gustatory branches of the inferior maxillary nerve: as the internal maxillary artery is about to sink into the spheno-maxillary fossa, it sometimes passes between the origins of the external pterygoid muscle.

The condyles of the jaw enjoy a slight rotation forwards and downwards in the temporal articular cavities, they can also advance a little from the glenoid depressions, and descend so as to rest on the zygomatic tubercles. The lower jaw can be moved in five directions; depressed, elevated, carried forwards, backwards, and rotated to either side. Depression, whereby the cavity of the mouth is opened, follows the simple relaxation of the elevator muscles, as when asleep in the erect posture; but a greater depression, as in yawning, is effected by the platysma, digastric and hyoidæan muscles; in opening the mouth very wide, the upper jaw is also raised by the sterno-mastoid and digastric muscles. Elevation of the lower jaw is performed by the combined actions of the temporal, the masseter, and the internal pterygoid muscles. The jaw is moved forwards by the internal pterygoid, the anterior fibres of the temporal, the superficial layer of the masseter, and, above all, by the external pterygoid muscles; if these of one side only act at a time, the chin will not only be advanced, but turned to the opposite side. The jaw is carried backwards by the deep layer of the masseter, and particularly by the posterior portion of the temporal muscle. In the rotatory motions, such as occur in mastication, the chin is moved from one side to the other by those muscles which can advance and draw back the condyles acting in alternate succession on opposite sides; during these rotatory motions, the elevators are also in slight action, and thus the food is perfectly comminuted by the pressure of the latter, and by the friction of the former against the uneven surfaces of the molar teeth.

The external pterygoid muscles are the chief agents in producing dislocation of the jaw; when the mouth is widely opened, their spasmodic action may suddenly draw the condyles and interarticular cartilages forwards off the tubercles into the zygomatic fossæ.

SECTION III.

VESSELS AND NERVES OF THE FACE.

THE arteries which are to be met with in the dissection of this region, are the facial and the terminating branches of the external carotid; the nerves are branches of the seventh and fifth pair. The *facial artery*, which is a branch of the external carotid, is seen winding round the side of the jaw, anterior to

the masseter, and running in a contorted course towards the commissure of the lips, and thence ascending along the side of the nose, to the internal canthus of the eye; in this course it sends off numerous *muscular branches*, the *coronary arteries of the lips*, the *nasal*, and terminates in the *angular*, which communicates with the ophthalmic artery, at the inner side of the orbit. The facial artery and its divisions are accompanied by corresponding veins: the *facial vein* is not coiled like the artery, but is straight, and lies to its outer side; at the lower edge of the jaw it generally, but not always, divides into two branches, one superficial joins the external jugular vein, the other passing deeper in the neck joins the internal jugular. *The external carotid artery*, which is seen ascending from the neck into the parotid gland, gives off numerous branches to its several lobules, and to the ear, and a little below the condyle of the jaw divides into the transversalis faciei, temporalis superficialis, and maxillaris interna. *The transverse artery of the face* crosses the masseter above, sometimes below the parotid duct, and divides into small muscular branches, some of which communicate with the facial and infra-orbital arteries. *The temporal artery* ascends behind the articulation of the maxilla, on the temporal aponeurosis, and soon divides into an anterior and posterior branch; the former is directed towards the forehead, supplies the integuments and muscles there, and communicates with the frontal branches of the ophthalmic artery; the posterior division of the temporal runs tortuously upwards and backwards, and divides into numerous branches, which supply the integuments and inosculate with the occipital and posterior auris arteries. *The internal maxillary artery* is the largest branch of the carotid; it bends in behind the neck of the lower jaw, between the bone and the internal lateral ligament, then runs tortuously between the pterygoid muscles upwards, forwards, and inwards, to the lower and back part of the orbit, where it sinks into the spheno-maxillary fossa; in this course it sends off the *middle artery of the dura mater*, the *inferior dental*, several *muscular branches* to the temporal, masseter, pterygoid, and buccinator muscles, and terminates by dividing into the *nasal*, *descending palatine*, and *infra-orbital arteries*. Veins accompany these different arteries, and in the parotid gland we find the temporal and internal maxillary veins forming a plexus, from which proceeds a considerable vessel called the external jugular vein, which will be afterwards seen descending superficially in the neck. (For the particular description of the bloodvessels of the face, see the Anatomy of the Vascular System.)

The nerves which are met with in the dissection of the face are branches of the seventh and fifth pair; those of the seventh, or the portio dura, have in general a *transverse* direction from behind forwards, are remarkable for their plexiform arrangement, and have numerous communications with the three branches of the fifth, which are distributed chiefly in a *vertical* direction along the anterior part of the face. The *portio dura* escapes from the temporal bone through the stylo-mastoid hole, and immediately gives off two or three small branches, the posterior *auricular*, *digastric* and *stylo-hyoid*; it then turns forwards into the parotid gland, superficial to the bloodvessels, here it divides into two large branches, the temporo-facial, and cervico-facial, which subdivide and join again by several filaments, forming the plexus, named *pes anserinus*, or *parotidœan plexus*, from which proceed several branches; some ascend obliquely forwards to the temple and forehead, others pass transversely to the muscles of the face, and several descend along the side of the neck, some parallel and others inferior to the side of the lower maxilla.

The fifth pair of nerves consist of three portions, viz., the opthalmic, superior maxillary, and inferior maxillary; a branch of each of these divisions is met with in the dissection of the face. The *frontal* nerve, which is a branch of the opthalmic, or first division of the fifth, is seen escaping from the orbit by the superciliary notch or foramen; it then ascends on the forehead, dis-

tributes its branches to the integuments and muscles, and communicates with the portio dura. The *infra-orbital* nerve, which is a branch of the superior maxillary, or second division of the fifth, is observed passing out of the infra-orbital foramen, behind the levator labii superioris alæque nasi, and dividing into several branches; the most of these pass obliquely downwards, and communicate freely with branches of the seventh pair. Through the mental foramen the *mental nerve* escapes: this is a branch of the inferior maxillary, or third division of the fifth pair; most of its branches ascend to the muscles of the lower lip, and several communicate with the portio dura. The temporo-auricular nerve is also a branch of the inferior maxillary, it lies deep-seated in the parotid gland, close to the meatus auditorius, to which it sends some branches, while others ascend with the temporal artery. (For the more particular description of the nerves of the face, see the Anatomy of the Nervous System.)

The mouth, fauces, and palate, are the parts of the face next in order to be examined; but as these are connected and continuous with the pharynx, and as this organ cannot be seen until the muscles of the neck have been removed, the student had better postpone the dissection of the former until he has become acquainted with the anatomy of the latter; we shall therefore proceed next to the dissection of the neck.

CHAPTER II.

DISSECTION OF THE NECK.

SECTION I.

[The neck extends from the base of the cranium and lower jaw above, to the sternum clavicle and circumference of the first rib below; it is divided into an anterior and a posterior cervical region. These regions are divided from each other on the superficies of the neck, by the anterior edges of the trapezius muscles; in the thickness of the neck, they are divided by a plane, corresponding to the anterior surface of the cervical vertebræ, and thence reflected a little forward on either side, to the anterior edges of the same muscle. Of these two regions, the posterior is comparatively of little importance in a surgical point of view, it is occupied principally by muscles which act upon the head and neck, and by their appropriate vessels and nerves. On this region it is sometimes necessary to operate for the removal of new formations, such as tumors of various kinds; but mostly adipose.

The anterior cervical region, on the other hand, is of great surgical importance in reference to the occurrence of new formations, and also in reference to morbid conditions of organs naturally situated there. In the dissection of this region, we find that it has three coverings, that it is divided naturally into three triangles, which are again subdivided, and that it presents four groups of muscles, which are considered as the muscles of the neck proper; besides those of the styloid process, of the tongue, of the pharynx, of the palate, and of the larynx, which constitute five more groups separate and distinct.

OF THE COVERINGS.

These are three in number. *First*, the *cutaneous* or *tegumentary* covering, which is thin, abundantly supplied with sebaceous follicles, and at its upper

part, with follicles which secrete the hair or beard; the skin here is loosely attached beneath, it is extensible and retractile, allowing great freedom of motion. *Second*, the *musculo-fascial* covering, composed of the platysma myoides muscle, and the fascia superficialis; this covering is composed of three laminæ, the platysma myoides being placed between two laminæ of the superficial fascia. *Third*, the *fascia profunda cervicalis*, which, according to the investigations of Godman, is divided into six processes, forming sheaths for different organs on the neck; and one of which descends behind the sternum, into the thorax, to form the fibrous lamina of the pericardium.

OF THE SUB-REGIONS.

The anterior cervical region is divided into three triangles by the sterno-cleido-mastoid muscles. One of these is between the two mastoid muscles, and is therefore called the *inter-mastoid;* the other two are above the clavicles on either side, and are the *supra-clavicular.* The *inter-mastoid* triangle is bounded on either side by the anterior edges of the mastoid muscles, inferiorly it terminates in an apex, at the sternum, and superiorly its base is formed by the inferior maxilla, the tube of the ear, and the anterior edge of the mastoid process. This triangle is divided into two spaces by the os-hyoides, and a transverse line drawn from it, to the edges of the mastoid muscles; the space above is the *supra-hyoideal*, and that below is the *infra-hyoideal;* in the former we find the tongue and epiglottis, the upper part of the pharynx, the palate, the external carotid artery and most of its branches, the internal jugular vein, the sublingual, gustatory and other nerves; the sub-lingual, sub-maxillary and parotid glands, besides numerous muscles; in the latter are situated the larynx and the trachea, the thyroid body, the œsophagus and lower part of the pharynx, the common carotid artery, internal jugular vein, and other vessels, the pneumo-gastric and other nerves. In the infra-hyoideal region, there are two points at which the common carotid artery may be tied, these points are separated by the omo-hyoid muscle; the point above this muscle is the *omo-mastoid* angle, bounded externally by the anterior edge of the mastoid muscle, and internally by the superior edge of the omo-hyoid; in this angle the common carotid artery is situated internally, the internal jugular vein externally, and the pneumo-gastric nerve between the two, and somewhat behind them, all being inclosed in a common sheath, over the fore-part of which runs the descendens noni nerve; these organs are here superficial, being directly beneath the coverings of the neck; the space for tying the artery below the omo-hyoid muscle, is the *omo-tracheal* triangle, which is bounded superiorly by the lower border of the omo-hyoid, externally by the anterior edge of the sterno-mastoid, and internally by the outer edges of the sterno-hyoid and sterno-thyroid muscles; in this space we find the same organs as above, and these holding the same relation to each other; they are however deeper seated, because in addition to the cervical coverings, they are overlapped by the sterno-mastoid and sterno thyroid muscles.

The *supra-clavicular* triangles of either side are bounded inferiorly by the clavicle, posteriorly or externally, by the anterior edge of the trapezius, and anteriorly by the external edge of the sterno-mastoid muscle. These triangles are each divided into two spaces by the inferior belly of the omo-hyoid muscle; the space above, which is very much the largest, is the *omo-trapezian;* that below is the *omo-clavicular;* in the former we find the cervical plexus, the upper part of the axillary plexus, arteries and veins, and in this space we sometimes find new morbid formations, or enlarged lymphatic ganglia; in the latter are situated the supra-scapular artery, the subclavian artery and vein, and the axillary plexus of nerves, also the termination of the external jugular vein; this is the space for tying the subclavian artery above the clavicle, it being here at the depth of an inch and a half to two inches, from the

surface of the neck behind the clavicle; the artery is bounded inferiorly and somewhat anteriorly by the vein, and superiorly and externally by the axillary plexus of nerves.

MUSCLES OF THE NECK.

As already stated, there are four groups considered as the muscles of the neck proper, these groups include eighteen pairs of muscles: in the first, two; in the second, four; in the third, five; and in the fourth, seven: besides these there are the five other groups referred to, including twenty-one pairs of muscles, and two single muscles, viz., fifth, the styloid muscles, three; sixth, the proper muscular structure of the tongue, four; seventh, the muscles of the pharynx, three; eighth, the muscles of the palate, four pairs and a single muscle; and ninth, the muscles of the larynx, seven pairs and a single muscle; so that upon the anterior region of the neck there are in fact thirty-nine pairs of muscles and two azygous muscles.

First Group, two pairs of Muscles.

Platysma Myoides,	*Vide p.* 40.
Sterno Cleido-Mastoideus,	" " 42.

This group extends from the thorax to the face and head, the first muscle is somewhat analogous to the sub-cutaneous muscle of certain inferior animals.

Second Group, four pairs of Muscles.

Sterno-Hyoideus,	*Vide p.* 44.
Sterno-Thyroideus,	" " 45.
Thyreo-Hyoideus,	" " 69.
Omo-Hyoideus,	" " 45.

This group extends from the thorax to the os-hyoides, and is for the most part situated in the infra-hyoideal space; the muscles are muscles of deglutition.

Third Group, five pairs of Muscles.

Digastricus,	*Vide p.* 46.
Mylo-Hyoideus, Genio-Hyoideus,	" " 48.
Hyo-Glossus, Genio-Hyo-Glossus,	" " 49.

This group extends between the os-hyoides, lower jaw and tongue, one of its muscles also reaching the base of the cranium; it is situated in the supra-hyoideal space; the muscles depress the lower jaw, elevate the os-hyoides and move the tongue, they accordingly act in mastication, in articulation, and in deglutition, in which last operation, they are antagonists to the second group, the former raising the os-hyoides in the commencement of deglutition and the latter afterwards depressing it. These three groups are all anterior to the larynx trachea, œsophagus and pharynx, while the next and fourth group is behind those organs, lying directly upon the bodies and transverse processes, of the cervical vertebræ.

Fourth Group, seven pairs of Muscles.

Longus Colii,	*Vide p.* 75.
Rectus Capitis Anticus Major, Rectus Capitis Anticus Minor, Rectus Capitis Lateralis,	" " 76.
Scalenus Anticus, Scalenus Medius, Scalenus Posticus,	*Vide p.* 77.

Fifth Group, three pairs of Muscles.

Stylo-Hyoideus, Stylo-Glossus, Stylo-Pharyngeus,	*Vide p.* 50.

These are the styloid muscles extending from the styloid process of the temporal bone, to the os hyoides, tongue, and pharynx; they are situated in the supra-hyoideal space, and are muscles of deglutition, being antagonists of the second group, and congeners of the third.

Sixth Group, four pairs of Muscles.

MUSCLES OF THE TONGUE.

Lingualis,	*Vide p.* 50.
Superficial Lingual Muscle, Transverse Lingual Muscle, Vertical Lingual Muscle,	*Vide p.* 50.

These are the proper muscles of the tongue, being situated entirely in that organ, and forming a large part of its substance. They are of course in the supra-hyoideal region.

Seventh Group, three pairs of Muscles.

MUSCLES OF THE PHARYNX.

Constrictor Pharyngis Inferior, Constrictor Pharyngis Medius, Constrictor Pharyngis Superior,	*Vide p.* 57.

These muscles are situated on the back and sides of the pharynx, they are muscles of deglutition, and are partly above, partly below, the level of the os-hyoides.

Eighth Group, four pairs; and a single Muscle.

MUSCLES OF THE PALATE.

Levator Palati, Tensor Palati, or Circumflexus,	*Vide p.* 60.
Palato-Glossus, or Constrictor Isthmi Faucium, Palato-Pharyngeus, Motor, or Azygos Uvulæ, a single Muscle,	*Vide p.* 61.

These muscles are situated upon the soft palate, and are above the os-hyoides, they act upon the velum, in such manner as to cut off the openings of the posterior nares, from the pharynx in deglutition, so as to prevent the food or liquids from being thrown up into the nares; or on the other hand, they cut off the mouth from the pharynx, so that fluids or gases may be thrown up into the nostrils, and pass out through the anterior nares.

Ninth Group, seven pairs; and a single Muscle.

MUSCLES OF THE LARYNX.

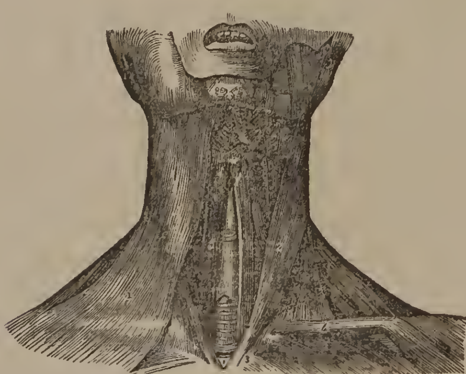
Crico-Thyroideus,	*Vide p.* 69.
Crico-Arytenoideus Posticus, Crico-Arytenoideus Lateralis,	" " 70.
Thyro-Arytenoideus,	" " 69.
Arytenoideus Obliquus, Arytenoideus Transversus, a single Muscle,	" " 70.
Aryteno-Epiglottideus, Thyro-Epiglottideus,	" " 71.

These are the proper muscles of the larynx, they are below the os-hyoides.

and are situated partly externally, partly internally, in reference to the circumference of the thyroid cartilage; they act upon the cartilages of the larynx in such manner, as to enlarge or diminish the area of the rima glottidis, and relax or make tense the chordæ vocales, hence they are the muscles of the voice.]

Raise the shoulders of the subject by blocks placed beneath them, so as to make tense the muscles in this region; divide the integuments, which are thin and delicate, near to, and in a line with the clavicle, also along the side of the jaw, from the chin to the mastoid process; connect these incisions by another made in a perpendicular direction, in the middle line from the chin to the sternum; dissect off the integuments from before backwards, in an oblique direction, from the chin towards the clavicle; this should be done cautiously, to avoid injuring the platysma or fascia; in the child and in the female there is generally more subcutaneous fat than in the male subject. The platysma myoides will be now fully exposed, and the sterno-mastoid and hyoid muscles partially so; in the middle line of the neck a chain of projections may be observed which can also be felt during life, viz., a little below, but at some distance behind the chin, is the body of the os-hyoides; inferior to this is the angle of the thyroid cartilage; next is the cricoid, below which the commencement of the trachea may be felt, on the forepart of which the soft swelling of the thyroid body can be discerned; and lastly, the continuation of the trachea descending into the chest. The distance between the chin and sternum, and the intervals between these several eminences, are much affected by the position of the neck from flexion to the extreme degree of extension. In the latter state, the space between the inferior maxilla and the os-hyoides, as also between the latter and the thyroid cartilage, is greatly augmented, the trachea also is elongated and drawn upwards from the thorax; in flexion, on the contrary, the os-hyoides is within the arch of the lower jaw, the cartilages of the larynx are pressed together, and but a short portion of the trachea is in this region. By altering the position of the neck, the student will soon perceive these facts, and cannot fail to conclude how much the details of any operation in the neck must be influenced by them.

Fig. 3.*



Platysma-myoides, or latissimus colli, is a thin and pale cutaneous muscle, analogous to the panniculus carnosus of quadrupeds; in many subjects weak, and even indistinct; it is situated on the forepart and side of the neck, ex-

* The superficial muscles of the neck. 1. The platysma myoides. 2. The sterno-cleido mastoideus. 3. Its sternal attachment. 4. Its clavicular attachment. 5. The sterno-hyoideus.

tending from the chest and shoulder to the face; its figure is somewhat square, but a little longer than it is broad, and narrower in the centre than at either end; it *arises* by many fine fleshy fibres from the cellular membrane, covering the upper part of the deltoid and pectoral muscles, a few also adhere to the clavicle; the fibres ascend obliquely inwards; at first loosely, afterwards closely connected to each other, and form a broad thin muscle, which covers the side and forepart of the neck; occasionally fine aponeurotic or short tendinous fibres may be noticed, prolonged into the cutis: *inserted*, first, into the skin and cellular tissue on the chin, decussating there with fibres from the opposite side; second, into the fascia along the side of the lower jaw, a few only into the bone: some fibres may be traced high on the face, and seen to join the depressor anguli oris, the zygomatic, and orbicularis palpebrarum muscles; and third, into the fascia, which covers the parotid, and which adheres to the meatus auditorius; some of these latter fibres take a waving transverse direction towards the commissure of the lips, and constitute the musculus *Risorius Santorini;* this transverse band is sometimes very strongly marked. *Use*, to depress the angle of the lips and the lower jaw, but if the mouth be closed it may elevate the integuments of the neck, and fold them into transverse wrinkles; it also serves to compress and support the several muscles, glands, and vessels in this region. The platysma is covered only by the skin; it partly conceals the clavicle and the deltoid and pectoral muscles, the sterno-mastoid, hyoid, and thyroid muscles; also the digastric and stylo-hyoid, the sub-maxillary gland, the lower part of the parotid, the side of the jaw, and some of the muscles of the face; also, in part, the *external jugular vein.*

This vein commences in the parotid gland, descends obliquely outwards over the sterno-mastoid muscle, where it lies very superficial, and then sinks deep behind the clavicle, and joins the subclavian vein or some of its branches. The upper portion of the external jugular vein is accompanied by a large nerve, which lies to its outer side, *superficialis colli*, a branch of the cervical plexus ascending to the parotid gland and external ear. This vein in its course down the neck receives several cutaneous veins, and almost always communicates with the internal jugular; it presents great varieties in its size and course, is sometimes double, and is sometimes even wanting. Superficial veins may also in general be marked descending along the anterior part of the neck; they arise about the os-hyoides and upper part of the thyroid body, and descend beneath some fibres of the platysma along the anterior edge of the mastoid muscle, and end in the internal or external jugular, or in the venæ innominatæ. The fibres of the platysma are closely connected to a layer of condensed cellular tissue, which in some subjects is very strong, and in some situations aponeurotic; this is the *superficial cervical fascia.* In some, the fibres of the platysma are so intermingled with this structure, that they cannot be perfectly separated, and must be raised together. Some writers designate this as the *deep* cervical fascia, and apply the term *superficial* fascia to the subcutaneous cellular tissue, which connects and supports the fibres of the platysma, a title it does not appear to me to deserve, except in very few instances, and in particular situations. This fascia extends over the anterior and lateral parts of the neck, is continued down over the forepart of the thorax, where it becomes cellular and adipose, ascends to the jaw, to which it is attached, expands over the parotid gland, and adheres to the cartilage of the ear; in this situation its strength is greatly increased: towards the lateral and posterior parts of the neck it becomes weak like cellular membrane; at the edge of the trapezius, one thin lamina passes superficial to this muscle, while the other stronger portion is continued beneath it to the ligamentum nuchæ, giving off in this course processes to inclose the different muscles. From the posterior or deep surface of this fascia, a lamina of mem-

brane is derived, which passes behind the sterno-mastoid muscle; this is the *deep cervical fascia,* whose connections are important, and may be examined in this stage of the dissection. If the superficial lamina be divided along the median line of the sterno-mastoid muscle, this deep fascia will be seen to be continuous with, or produced from, the superficial, and to pass behind the anterior border to the posterior surface of that muscle, so that the latter, as also the omo-hyoid, and the other muscles in this region, may be considered as inclosed between these fasciæ, each in a sort of sheath; at the lower part of the neck it is strong, and adheres to the inter-clavicular ligament and posterior edge of the sternum and clavicles. Some loose fatty substance is here interposed between it and the superficial layer; as the deep fascia extends upwards, it covers and adheres to the sheath of the cervical vessels, and arriving at the space between the trapezius and mastoid muscles, it becomes, at first, weak and cellular, but inferiorly as it accompanies the great vessels beneath the clavicle it is dense, and serves to inclose the subclavian muscle, and is attached to the costo-clavicular, or coracoid ligament or membrane; superiorly it is lost on the branches of the cervical plexus of nerves; at the superior and lateral parts of the neck it sinks deep, behind the angle of the jaw, to which it adheres, and is connected to the styloid process of the temporal bone, and to the stylo-maxillary ligament, which it may be said to form; absorbent glands, the lower part of the parotid, and much cellular membrane, here lie between these two fasciæ. In this situation collections of matter often form, the result of cynanche parotidæa, or of inflammation of some of the lymphatic glands; such collections are productive of great inconvenience, causing such swelling and tension, as to interfere with the motions of the jaw, and with the act of deglutition. The cervical fasciæ bind down the muscles and support the vessels and glands in this region; at the lower part of the neck they serve to protect the trachea and the upper part of the thorax from the pressure of the atmosphere during inspiration. In the subsequent dissection of the deep muscles of the neck, this fascia will be found continued by lateral slips from the external sides of the sheaths of the cervical muscles to form another extensive sheath, the *prevertebral fascia;* this adheres above to the occipital bone, and the adjacent muscles; on either side, to the tips of the transverse processes, covers and binds down the longi colli, recti, and scaleni muscles, connected in front by loose reticular membrane to the pharynx and œsophagus, and inserted below into the first ribs, clavicles, and subclavian muscles; it adheres to, and forms prolongations around the brachial vessels and nerves, and separates the axillæ from the inferior triangular regions of the neck; more internally it overlaps the two pleuræ, and by its various inter-muscular and inter-vascular connections with the superficial layers which adhere to the sternum and its ligaments, completes the cervico-thoracic septum, which, when viewed from the cavity of the thorax, appears as a vaulted partition perforated by various funnel-shaped passages for the several tubes and vessels, passing in and out of the chest, attached to each by cellular and fibrous prolongations which are lost on their individual parietes. Dissect off the platysma and superficial fascia, and examine the subjacent muscles, the second pair of the first order. In the course of this dissection are seen branches of the cervico-facial division of the seventh pair; many of these arch along the side of the neck towards the os-hyoides and the chin, others descend to join the cutaneous branches of the cervical plexus, and they are all distributed to the platysma, fascia, and integuments.

STERNO-CLEIDO MASTOIDEUS, long and flat at the extremities, but somewhat round in the centre; placed at the anterior and lateral part of the neck; *arises* by a strong flat tendon with fleshy fibres posterior to it, from the upper and anterior part of the first bone of the sternum, also by short aponeurotic and fleshy fibres from the upper and anterior edge of the sternal third, some-

times half of the clavicle; a small triangular space separates these two origins, through which small vessels and some cellular membrane pass: this space corresponds to the sterno-clavicular articulation.

The sternal and longer portion of this muscle ascends obliquely backwards and outwards, and overlaps the clavicular, which ascends vertically; about the middle of the neck they are intimately joined; *inserted* by a tendon which is thick and rounded anteriorly, but thin, broad, and aponeurotic posteriorly, into the upper part of the mastoid process, and into the external third of the superior transverse ridge of the occipital bone. *Use*, the sternal portion can rotate the head so as to turn the face towards the opposite side: the clavicular can bend the head and neck to its own side, so as to approximate the ear and shoulder; and if the two portions of the muscle on each side act together, they will move the head downwards and forwards, but if the muscles on the back of the neck be in action, so as to fix the vertebræ and head, then these muscles, particularly the sternal portions, may assist in still further extending the neck, and carrying the head backwards, so as to turn the face upwards, in consequence of their insertion being posterior to the centre of motion in the occipital condyles; this appears to be the case in tetanus: these muscles can also assist in laborious respiration, by raising and fixing the shoulders. This muscle is covered by the integuments, platysma, superficial fascia, external jugular vein, ascending branches of the cervical plexus of nerves, descending branches of the portio dura, and by a small portion of the parotid gland; it conceals part of the sternum and clavicle, of the sterno-hyoid, sterno thyroid, omo-hyoid, and digastric muscles, also the lower part of the cervical vessels, and several glands. The spinal accessory nerve perforates it obliquely a little above its centre, and near its posterior surface; this nerve is a division of the eighth pair, it distributes small branches to the mastoid and trapezius muscles, and joins freely with the cervical plexus; the spinal accessory does not always perforate, but sometimes passes posterior to the mastoid muscle; it is supposed to associate the nerves and muscles of the neck with the respiratory system.

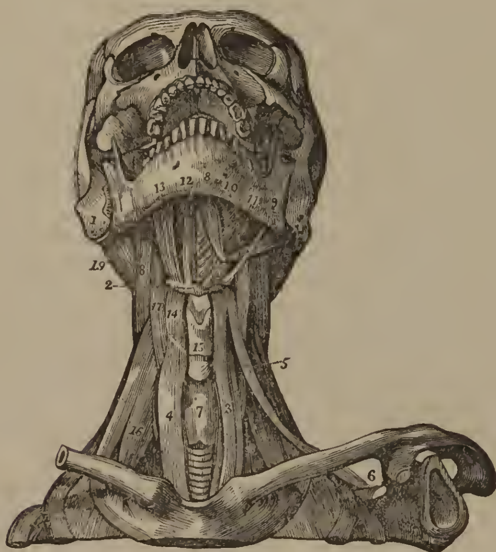
The student may remark that the two sterno-mastoid muscles bound a large triangular space situated on the forepart of the neck, the apex at the sternum, the base at the jaw: this is divided by the mesial line into two lateral portions, which are named the anterior lateral triangles of the neck.

Between the mastoid and the trapezius muscles also, on each side, a large triangular space is inclosed, the base formed by the clavicle, the apex by the mastoid process; this space is called the posterior lateral triangle of the neck. Both these triangular regions may be observed to be subdivided into two by the omo-hyoid muscle, which crosses the neck obliquely from the shoulder to the os-hyoides. Thus on each side of the middle line four triangular spaces may be noticed, principally formed by the trapezius, sterno-mastoid, and omo-hyoid muscles; these triangles are distinguished by the terms—1. posterior inferior; 2. posterior superior; 3. anterior inferior; and 4. anterior superior. We do not at present allude to the important space bounded by the digastric muscle.

The student should examine each of these regions, and consider the parts situated in each. These spaces can be ascertained during life, and therefore an accurate knowledge of the contents of each may be of practical importance. 1. The *posterior inferior triangle* is that small space partly behind the clavicular portion of the mastoid muscle, and partly between it and the trapezius, above the clavicle and below the posterior belly of the omo-hyoid muscle; in this space we find the trunk and several branches of the subclavian artery, vein, and the brachial plexus of nerves; it is here that the operation of tying the subclavian artery, in case of axillary aneurism, is recommended to be performed. 2. The *posterior superior triangle* is above the posterior belly of the

omo-hyoid, and between the mastoid and trapezius muscles; it contains the cervical plexus of nerves, several lymphatic glands, and a great quantity of cellular membrane. 3. The *anterior inferior triangle* is above the sternal third of the clavicle, between the median line and anterior belly of the omo-hyoid, and rather behind the sterno-mastoid muscles; this space contains the carotid artery, jugular vein, and accompanying nerves, also the lateral lobe of the thyroid body, all of which are covered by the sterno-mastoid, hyoid, and thyroid muscles. 4. The *anterior superior triangle* is between the sterno-mastoid and anterior belly of the omo-hyoid muscles; the apex is formed by the decussation of these muscles, and is opposite the cricoid cartilage; the base is superiorly marked by the digastric muscle and lingual nerve; this space also contains the great vessels and nerves, which here, however, are

Fig. 4.*



only superficially covered, so that in this situation the operation of tying the carotid artery can be more easily effected. Divide the sterno-mastoid muscle about its centre, and reflect each portion towards its attachment; at the lower part of the neck, behind and between the sterno-mastoid muscles, are seen the following:

Sterno-Hyoides is long, flat, and thin, *arises* within the thorax from the posterior surface of the first bone of the sternum, cartilage of the first rib, sternal end of the clavicle, and sterno-clavicular capsule; ascends obliquely inwards, approximating its fellow above, and is *inserted* into the lower border of the os-hyoides, internal to the omo-hyoid. *Use*, to depress the os-hyoides, pharynx, and larynx. This muscle is covered by the sternum and clavicle,

* The muscles of the neck. 1. The mastoid process of the temporal bone. 2. The os hyoides. 3. The sterno-hyoideus muscle. 4. The sterno-thyroideus. 5. The omo-hyoideus. 6. Attachment of the omo-hyoideus to the superior costa of the scapula. 7. The hytroid body. 8. The anterior belly of the digastricus. 9. Its posterior belly. 10. Its median tendon perforating the stylo-hyoid muscle, and connected to the os hyoides by a tendinous pulley. 11. The mylo-hyoideus. 12. The genio-hyoideus. 13. The hyo-glossus. 14. The thyro-hyoideus. 15. The thyroid cartilage. 16. The scalenus anticus muscle. 17. The rectus capitis anticus major. 18. The levator anguli scapulæ. 19. A portion ofthe splenius.

by the sterno-mastoid and integuments; it lies on the sterno-thyroid, crico-thyroid, and thyro-hyoid muscles, and on the thyroid gland and its vessels; a tendinous line often intersects it about its centre. Cut this muscle across, and reflect each portion towards its attachments, and we see the following pair of muscles:

Sterno-Thyroideus is broader and shorter than the last, *arises* from the posterior surface of the sternum and cartilage of the second rib, ascends obliquely outwards, and is *inserted* into the oblique line on the ala of the thyroid cartilage. *Use*, to depress the larynx. This muscle is covered by the sterno-mastoid and hyoid muscles, and by the skin; it conceals the arteria and vena innominata, the carotid and subclavian vessels, and adjacent nerves, also the thyroid body, and the trachea; between it and the latter there is a considerable quantity of cellular membrane, which contains several veins (*inferior thyroid* v.) Several filaments of the descendens noni nerve are distributed to this and to the former muscle; it also is occasionally intersected by a tendinous line. It is between the sterno-thyroid muscles that the operation of tracheotomy is performed, while that of laryngotomy is between the sterno-hyoid muscles, and between the thyroid and cricoid cartilages.

Omo-Hyoideus is long, slender, and digastric, situated obliquely along the inferior, lateral, and forepart of the neck; it *arises* broad and fleshy from the superior costa of the scapula behind its semilunar notch, from the ligament covering that notch, sometimes from the base of the coracoid process, and sometimes also from the acromial end of the clavicle; it ascends obliquely forwards a little above the clavicle, passes beneath the sterno-mastoid muscle, where it is generally tendinous, except in the very young subject; becoming again fleshy, it ascends nearly vertical along the outer side of the sterno-hyoid, and is *inserted* fleshy into the lower border of the os hyoides, at the junction of its body and cornu, external and anterior to the insertion of the sterno-hyoid. *Use* (the muscle of one side cannot act independent of the other), both draw the os hyoides, pharynx, and larynx, downwards and backwards, and in deglutition serve to urge the food into the œsophagus; they also make tense the cervical fascia. The origin of this muscle is concealed by the trapezius, it is anterior to the insertion of the levator anguli scapulæ, and between the serratus magnus and supra-spinatus muscles; the posterior belly is covered by the integuments and fascia, in some the clavicle overhangs it; it divides the great posterior lateral triangle of the neck into an inferior and superior part, as was before mentioned; this portion of the omo-hyoid can frequently be distinguished in the living neck. The tendon crosses the carotid artery and jugular vein, and is covered by the sterno-mastoid, which can thus move more easily on this structure. The anterior belly and insertion are covered by the integuments and fascia; this portion of the muscle divides the anterior lateral triangle of the neck into an inferior and superior part. The omo-hyoid is inclosed through its whole course between septa of the cervical fascia, it crosses over the scaleni muscles, the brachial plexus, phrenic, pneumo-gastric and sympathetic nerves, the carotid artery, jugular vein, and superior thyroid vessels.

Beneath the three last described muscles, and lying on the trachea and sides of the larynx, is a large, soft, red mass, of a crescentic shape, the concavity directed upwards; this is the *thyroid body;* it is in general larger and of a deeper color in the child than in the adult or old, and in the female than in the male; its size, however, varies considerably in different individuals, even of the same sex and age. It consists of two large pyramidal portions, called *lateral lobes*, connected together by a narrow slip, *the middle lobe*, or *isthmus;* the latter is thin and flat, and closely connected to the second, third, and fourth rings of the trachea; the lateral lobes are plump and convex, large below, pointed above, placed by the side of the trachea and larynx,

and extending as high as the alæ of the thyroid cartilage; the left lateral lobe rests on the œsophagus, and both right and left overlap the carotid artery, inferior thyroid vessels, and recurrent nerve; they are covered by the sterno-mastoid, hyoid, thyroid, and omo-hyoid muscles, by the platysma and skin; they lie on the side of the trachea and larynx, on the crico-thyroid and inferior constrictor of the pharynx. The middle lobe is very irregular, it is sometimes deficient, in other cases it is full and broad, and might even cause embarrassment in tracheotomy; in some cases it passes behind the œsophagus, or between this tube and the trachea, a circumstance which might be productive of great inconvenience, and even danger, in the event of enlargement of this body occurring in one in whom this malformation existed. A narrow slip is often seen to ascend from the middle lobe as high as the os hyoides. A small muscular band is occasionally found to arise from its upper border, and to be inserted into the base of the os hyoides, or angle of the thyroid cartilage, named by Sœmmering "*levator glandulæ.*" In the infant the lower part of the thyroid is connected to but not continuous in structure with the thymus gland. This organ has no perfect capsule, a fine cellular tissue only surrounds it; it is of a soft and spongy texture, the cells contain a yellow, serous, and sometimes an oily fluid, it appears composed of a number of granulations united by cellular tissue into lobules, the serous fluid is contained in the connecting cellular membrane, no excretory duct has been discovered, nor does there appear to be any communication between the lobes and the lobules, except through the medium of the bloodvessels, which are of considerable size; four arteries, two from the carotid and two from the subclavian, are distributed to it, the former border its superior margin, the latter bend along its inferior and posterior portions; several veins issue from it, small superiorly, but very large and numerous below. This body has been by many considered as glandular, and named accordingly the thyroid gland, but there does not appear any evidence to support this opinion; it cannot belong to the secreting glands, unless we admit that its veins (which are certainly very large) serve the additional office of excretory ducts, neither does it appear to have any peculiar connection with the lymphatic or absorbent system. Anatomical writers usually describe it in connection with the larynx, but without any reason, except from its contiguity to that organ. Although it is an opinion prevalent among many physiologists, that the thyroid body is an organ for sanguification, yet it may be affirmed that its use is by no means fully ascertained.

The thyroid body is very subject to enlargement, which is sometimes partial, sometimes general; this affection is named *bronchocele* or *goitre*, and presents great varieties as to size, form, and consistence of the tumor, in some being firm and regular, in others very uneven, and soft or pulpy to the feel. Next dissect the muscles at the upper part of the neck.

Digastricus, placed at the lateral and anterior part of the neck, thick and fleshy at each extremity, round and tendinous in the centre, *arises* from a groove in the temporal bone, internal to the mastoid process, descends obliquely forwards and inwards, ends in a round tendon which perforates the stylo-hyoid muscle, and is connected to the cornu of the os hyoides by a dense fascia, sometimes by a tendinous ring like a pulley; the tendon is then reflected upwards and forwards, and soon ends in the anterior fleshy belly, which continuing forwards and inwards, is *inserted* into a rough depression on the inner side of the base of the jaw, close to the symphysis. *Use*, to depress the lower jaw, and, when the mouth is closed, to elevate the os hyoides, tongue, and larynx; the posterior belly can also draw these backwards and upwards, and the anterior upwards and forwards, so that this muscle can exert great influence in deglutition; it can also draw the head backwards if the chin be fixed. The digastric is covered posteriorly by the sterno-mastoid

and splenius, and by a portion of the parotid, more anteriorly by a few fibres of the stylo-hyoideus and a small part of the submaxillary gland, by the cervical fascia, platysma, and skin; it passes across the styloid muscles, the external and internal carotid, the labial and lingual arteries, the eighth, ninth, and sympathetic nerves; also the origin of the hyo-glossus and the insertion of the mylo-hyoid.

In the position in which the subject is placed during this dissection, this muscle forms the inferior or convex border of a semicircular space, the *digastric region*, the superior straight edge of which is marked by the side of the maxilla, and by a line continued from its angle to the mastoid process; the skin, platysma, and cervical fascia close it in superficially, and the side of the jaw overhangs it; its deep, or superior surface is formed by the mylo-hyoid and lingual muscles, and by the side of the pharynx. This region is divided by the stylo-maxillary ligament into two spaces, the posterior or parotidæan, the anterior or submaxillary.

The *parotidæan space* is the smaller, bounded behind by the mastoid process and meatus auditorius, and more deeply by the vaginal and styloid processes; it extends as high as the maxillary articulation; the stylo-maxillary ligament, ramus and angle of the jaw, and internal pterygoid muscle, bound it anteriorly and separate it from the submaxillary space; it is prolonged to some depth within the neck and ramus of the jaw between the pterygoid muscles; this space contains the parotid gland, which is firmly wedged into it around the jaw, and impacted into all its irregular recesses; also several absorbent glands, the external carotid artery and its terminal branches; the commencement of the external jugular vein, the seventh nerve and its plexus, and more deeply the origin of the three styloid muscles, the internal carotid artery, internal jugular vein, and the eighth, ninth, and sympathetic nerves.

The anterior, or *submaxillary space*, is larger, is bounded above by the mylo-hyoid muscle, and by the mucous membrane of the mouth reflected from the jaw to the tongue; the muscle like a shelf divides it into a superficial and a deeper or sublingual portion, which communicate around the outer border of that muscle. This space contains superficially the submaxillary and several lymphatic glands, the facial artery and vein, with their numerous branches, and the mylo-hyoid nerve of the fifth pair, and the submaxillary ganglion; in the deeper or sublingual portion of this space, that is, above the mylo-hyoid muscle, and between it and the mucous membrane or the floor of the mouth, are contained the gustatory and lingual nerves, and more deeply still the glosso-pharyngeal; also the Whartonian duct, the lingual artery and vein, with their tortuous branches, and the sublingual gland; these last-mentioned objects cannot be seen in the present stage of the dissection.

The *submaxillary* is the second of the salivary glands, of an oval form and pale color, surrounded by cellular membrane and several absorbent glands, covered by the skin, platysma, and fascia, bounded posteriorly by the digastric tendon, externally by the internal pterygoid muscle and stylo-maxillary ligament; anteriorly by the side of the maxilla, and internally by the anterior belly of the digastric; it rests on the mylo-hyoid, stylo-hyoid, and hyo-glossus muscles; a small process of the gland accompanies its excretory duct, turns round the posterior edge of the mylo-hyoid, and lies between the upper surface of that muscle and the membrane of the mouth; this process frequently joins the sublingual gland. The facial artery and vein pass through a deep groove in this gland. The duct of this gland is called *Whartonian duct;* it *arises* by numerous fine cœcal radicles from the lobules of the gland, leaves it at its outer end, winds above the mylo-hyoid muscle, and runs forwards and inwards towards the frænum linguæ, by the side of which it *opens* into the mouth; the orifice can be distinctly seen in the mouth in a promi-

nent papilla, which appears when the anterior part of the tongue is raised; this duct is about two inches and a half long, is thin and transparent, its coats are weaker, but its calibre is larger than in Steno's duct; the gustatory nerve accompanies it, at first superior, but afterwards inferior to it; sometimes a second or accessory duct is met with.

The submaxillary gland is subject to the same *morbid* changes as those which have been alluded to in speaking of the parotid gland. Its removal in case of scirrhus is also spoken of by authors, and this operation has been described as having been frequently performed; most probably, however, many of these recorded accounts were rather cases of tumors which have pressed this gland aside, or, causing its absorption, have thus come to occupy its place. The Whartonian duct is not unfrequently obstructed near to, or closed at its termination in the mouth, the saliva, and often calcareous matter, then distend it into the form of a tumor of variable size, which is situated beneath the tongue, and causes more or less inconvenience to the latter; this disease is termed Ranula. Detach this gland from the mylo-hyoid, turn it outwards, leaving the duct and deep process to be further examined afterwards; separate the anterior belly of the digastric from the chin and we see the following muscle:

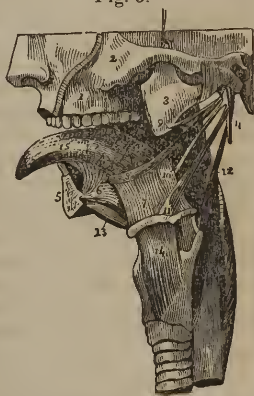
Mylo-hyoideus, triangular, *arises* from the oblique line (the myloid ridge,) on the inner surface of the side of the maxilla, which line descends obliquely from beneath the last molar tooth towards the chin; the fibres descend obliquely inwards and backwards to the mesial line, and *are inserted* into the base of the os hyoides, and along with its fellow, into a middle tendinous line between that bone and the chin, which latter point they seldom reach. *Use*, to elevate the os hyoides and tongue, so as to press the latter against the palate. This muscle is covered by the submaxillary gland, and by the digastric; it lies on the hyo-glossus, stylo-glossus, and genio-hyoid muscles, and conceals the Whartonian duct, the lingual and gustatory nerves, and sublingual gland. This pair of muscles seem like a digastric muscle, the tendon being in the mesial line, opposite to the raphe in the pharynx; they might almost be considered as continuations of the superior constrictors of that organ, the gustatory nerve at each side intervening and marking the separation. Detach this muscle from the os hyoides and from its fellow; in the middle line we shall then see the following pair:

Genio-hyoideus, short and round, *arises* by a small tendon on the inner side of the chin, above the digastric, descends obliquely backwards, and is *inserted* broad and fleshy into the base of the os hyoides. *Use*, to draw the os hyoides upwards and forwards, to push the tongue against the incisor teeth, or protrude it from the mouth; this pair of muscles lie superior to the digastric and mylo-hyoid, and inferior to the genio-hyo-glossus. Reflect the genio and mylo-hyoid muscles towards the lower jaw, and the *sublingual space* within the submaxillary will be exposed; the mucous membrane of the mouth bounds this above; the side of the tongue and pharynx internally, the mylo-hyoid muscle forms its floor. In this space are lodged the sublingual gland adhering to the mucous membrane, the gustatory and lingual, or the sentient and motor nerves of the tongue, with their connecting plexus, on the surface of the hyo-glossus muscle, the chorda tympani thrown off from the gustatory to the submaxillary ganglion, the Whartonian duct rising obliquely forwards to the side of the frænum linguæ, accompanied usually by a lobe of glandular structure, a *socia*, as in the case of Steno's duct, the lingual artery emerging from under the hyo-glossus, and dividing into the sublingual and ranine, the styloid and lingual muscles, and the glosso-pharyngeal nerve winding around the stylo-pharyngeus muscle. Observe how any change of position of the head, neck, or jaw, affects this space as to dimension, aspect, and form; any such, therefore, during life, must materially influence an ex

amination or operation in this region; if the jaw be depressed, or the neck flexed, it will become compressed, or almost obliterated within the side of the jaw; but if the mouth be closed, and the head thrown back and slightly turned to the opposite side, it will present an extended plane surface, through which the sub-maxillary gland can be felt and even seen. In this gland and the surrounding cellular tissue inflammation occasionally occurs with much swelling and suppuration beneath the cervical fascia; the abscess in some cases opens into the mouth; hæmorrhage is not uncommon, and it may be necessary to open the cavity through the skin. A free semicircular or crucial incision will open it into a superficial cavity, but a small vertical wound will only give the appearance of a narrow pit, or deep axilla, without exposing its contents to view.

The *sublingual* is the third and smallest of the salivary glands, oblong, placed beneath the anterior and lateral part of the tongue, covered superiorly by the mucous membrane, to which it adheres, and resting inferiorly on the mylo-hyoid, is in contact internally with the genio-hyo-glossus, and is connected externally to the deep process of the submaxillary gland, and partly resting in a depression in the lower maxilla. This gland opens by several small ducts, some of which join the Whartonian canal, others perforate the mucous membrane of the mouth, between the tongue and inferior canine and bicuspis teeth, by small openings which may be observed on a sort of crest or fold of the mucous membrane in this situation. The three salivary glands, though generally separated from each other, yet are in some cases so joined together as to resemble one irregular glandular mass, the parotid being united to the submaxillary behind the angle of the jaw, and the latter being connected to the sublingual around the mylo-hyoid muscle.

Fig. 5.*



Hyo-glossus is flat and thin, *arises* from the cornu and part of the body of the os hyoides, ascends a little outwards, *inserted* into the side of the tongue. *Use*, to render the dorsum of the tongue convex by depressing its side; it may also elevate the os hyoides and base of the tongue. This muscle is covered by the mylo-hyoid, by the duct and deep lobe of the submaxillary gland, also by the sublingual gland and lingual nerve, and a plexus between this and the gustatory nerve; it lies on the middle constrictor of the pharynx, the lingual artery, and the substance of the tongue.

Genio-hyo-glossus is triangular or fan-shaped, *arises* by a small tendon from an eminence inside the chin, beneath the frænum linguæ; thence the fibres radiate, the superior ascend, and turn forwards towards the tip of the tongue; the middle also ascend, some inclining forwards, others backwards; the inferior and posterior pass backwards and downwards to the base of the os hyoides; *inserted* into the mesial line of the tongue from the apex to the base, and into the body or lesser cornu of the os hyoides. *Use*, the posterior fibres can draw the os hyoides towards the chin, and thus protrude the tongue from the mouth, and bend its tip

* The styloid muscles and muscles of the tongue. 1. The superior maxillary bone. 2. The malar bone. 3. A portion of the ramus of the inferior maxillary bone drawn upwards in order to show the origin of the styloid muscles. 4. The styloid process of the temporal bone. 5. The inferior maxillary bone divided at the symphysis. 6. The genio-hyo-glossus muscle. 7. The hyo-glossus. 8. The stylo-glossus. 9. The stylo-maxillary ligament. 10. The stylo-hyoid ligament. 11. The stylo-hyoideus muscle. 12. The stylo-pharyngeus muscle. 13. The genio-hyoideus muscle. 14. The thyro-hyoideus muscle. 15. The tongue.

down towards the frænum; the middle portion can depress the middle of the tongue and make it concave from side to side; it can also draw it forwards so as to enlarge the opening of the fauces. This muscle is therefore used in mastication and deglutition, also in the articulation of several letters. The several muscles last described cover this muscle externally, internally it is in contact with its fellow.

Lingualis is a fasciculus of fibres taking a longitudinal course on the inferior surface of the tongue from the base to the apex, and intermixing with the muscles on either side, so that it appears as being derived from these rather than a distinct muscle; the fibres are attached through their whole length, and are mixed with a soft, fatty substance, with but little cellular tissue; anteriorly they are broader and more distinct; they are situated between the genio-hyo-glossus internally, and the hyo and stylo-glossus externally. *Use*, to shorten the tongue and bend the tip downwards and to one side. External to the muscles now described, we see the three styloid muscles.

Stylo-Hyoideus *arises* from the outer side of the styloid process near its base, descends obliquely forwards parallel to the posterior belly of the digastric, whose tendon generally perforates this muscle; *inserted* into the cornu and body of the os hyoides and into the fascia, which connects the digastric tendon to this bone. *Use*, to co-operate with the posterior part of the digastric, in raising and drawing back the os hyoides and tongue. This muscle is nearly superficial, but at first is covered by the parotid; the digastric lies to its external side and the external carotid artery to its internal; this vessel is posterior to the lower part of the muscle, but anterior to its origin; a ligament often accompanies the stylo-hyoid muscle, from the styloid process to the cornu of the os hyoides; it is named the stylo-hyoid ligament, and is sometimes ossified. Raise the digastric and stylo-hyoid, and we see the remaining styloid muscles.

Stylo-Glossus *arises* tendinous and narrow from the inner side of the styloid process near its point, and from the stylo-maxillary ligament; descends obliquely forwards and inwards, and is *inserted* into the side of the tongue; its fibres overlap and unite with those of the hyo-glossus, and can be traced as far as the tip. *Use*, to draw the tongue backwards, and to one side, and to raise the tip behind the upper incisor teeth. It is covered by the sub-maxillary and lingual glands, by the gustatory nerve and mucous membrane.

Stylo-Pharyngeus, long and narrow, *arises* from the back part of the root of the styloid process, descends inwards and very little forwards, passes between the superior and middle constrictors of the pharynx, with which it mixes; is *inserted* with these into the side of the pharynx, also into the cornu of the os hyoides and thyroid cartilage. *Use*, to elevate and dilate the pharynx, so as to receive the food from the tongue. It is covered by the stylo-hyoid, middle constrictor, and external carotid, and it lies on the superior constrictor, internal carotid, sympathetic, and par vagum; the glosso-pharyngeal nerve winds round it.

SECTION II.

DISSECTION OF THE VESSELS AND NERVES OF THE NECK.

The arteries which are met with in dissecting the neck, are the carotid and subclavian of each side, and their several branches; the veins are the external and internal jugular and subclavian, with numerous branches; the nerves are the gustatory branches of the fifth, the eighth, and the ninth pair,

the sympathetic, and the anterior branches of the eight cervical and first dorsal spinal nerves. The *right carotid artery* arises from the arteria innominata, behind the right sterno-clavicular articulation; the *left carotid* arises from the upper part of the arch of the aorta; in other respects these arteries are nearly similar; both ascend by the side of the trachea and larynx, surrounded by a sheath of cellular membrane, on the forepart of which are seen the branches of the descendens noni nerve; behind the sheath lies the sympathetic, and within it are the jugular vein, lying to the outside of the artery, and the par vagum nerve, between, and rather behind both these vessels; opposite the os hyoides, each carotid divides into two branches, viz., the internal and external; the *internal carotid artery* is the larger branch, lies deeper in the neck, and more external; it ascends tortuously along the forepart of the transverse processes of the vertebræ to the base of the cranium, enters this cavity, through the foramen caroticum in the temporal bone, and is distributed to the brain. The *external carotid artery* ascends towards the parotid gland, being crossed by the digastric and stylo-hyoid muscles, and by the lingual and portio dura nerves; in this course it gives off several branches, viz., the superior thyroid, lingual, labial or facial, auricular, occipital, pharyngeal, transverse facial, internal maxillary, and temporal.

The *subclavian arteries* are situated at the inferior and lateral part of the neck; the *right* arises from the arteria innominata, the *left* from the posterior part of the arch of the aorta; each subclavian artery passes upwards and outwards to the anterior scalenus, behind which it passes; it then turns downwards and outwards behind the clavicle, and over the first rib, into the axilla; the difference in the origin causes an important difference in the situations and connections of the right and left subclavian in the early part of their course; the right, being shorter and nearly transverse, lies higher in the neck, and more superficial than the left, which arises deep in the thorax, out of which it ascends perpendicularly before it turns outwards to pass between the scaleni; after this point, these vessels are similar in every respect, and give off the following branches, viz., arteria vertebralis, mammaria interna, axis thyroidea, cervicalis profunda, and inter-costalis superior.

The external jugular vein has been already noticed; the *internal jugular vein* of each side commences at the termination of the lateral sinus in the foramen lacerum posterius, descends along the outer side, first, of the internal, and afterwards of the common carotid artery, and at the inferior part of the neck joins the *subclavian vein*, which returns the blood from the upper extremity, and accompanies the subclavian artery, but separated from it by the anterior scalenus muscle; the junction of each jugular and subclavian, which is posterior to the sternal end of each clavicle, forms the right and left venæ innominatæ; these veins enter the chest, and uniting, commence the superior vena cava, as will be seen in the dissection of the thorax. (For the particular description of the vessels of the neck, *see Vascular System.*)

The *gustatory nerve* is the principal branch of the inferior maxillary, or third division of the fifth pair; it is seen, on dividing the mylo-hyoid, taking an arched course below the sublingual gland, parallel to the lingualis, and stylo-glossus muscles, from within the angle of the jaw towards the tip and side of the tongue; it accompanies the Whartonian duct, at first above, afterwards beneath it, and then rises above the sublingual gland, between it and the tongue; it gives branches to the submaxillary and sublingual glands, and terminates in fine filaments, which are lost in the papillæ beneath the mucous membrane, covering the sides and tip of the tongue. The chorda tympani joins it near the condyle, and parts from it opposite the angle of the lower maxilla; this delicate nerve then swells into a small ganglion, whose branches pass into the submaxillary gland. The *eighth pair of nerves* leave the cranium by the foramen lacerum posterius, anterior to the jugular vein; it im-

mediately separates into its three portions, the internal or glosso-pharyngeal, the external or spinal accessory, and the middle or par vagum. The *glosso-pharyngeal* is connected to the stylo-pharyngeus muscle, its name denotes its destination; the arch which it forms, as it runs to the base of the tongue, is inferior to and deeper in the neck than the gustatory nerve. The *spinal accessory nerve* separates from the par vagum, and in general winds round behind the internal jugular vein, perforates the sterno-mastoid muscle, as was before mentioned, and distributes its branches to it and to the trapezius; several of these also communicate with the cervical plexus, and descend towards the acromion. The *par vagum* or *pneumogastric* descends along the neck, between, and rather behind the carotid artery and jugular vein, and inclosed in their sheath; it then passes through the thorax, and terminates on the stomach. The cervical portion only of this nerve is to be observed at present; from it arise several branches, viz., communicating branches to join the sympathetic and lingual; pharyngeal branches to the side of the pharynx; superior laryngeal nerve, which takes an arched course behind the great vessels to the thyroid cartilage, and is distributed to the upper part of the larynx, and small cardiac branches, which join similarly named branches of the sympathetic nerve. At the inferior part of the neck, on each side of the trachea, a large nerve, the *inferior laryngeal* or *recurrent nerve,* is seen; this is also a branch of the par vagum. On the *right* side, this nerve *arises* at the lower part of the neck, turns round the subclavian artery, and passing behind it and the carotid, pursues its course upwards and inwards, behind the thyroid body, to the lower and back part of the larynx; on the *left* side the recurrent nerve *arises* in the thorax, opposite to the lower part of the arch of aorta, under which it passes, and then attaching itself to the forepart of the œsophagus, ascends to the larynx, to the muscles of which it is distributed like that of the opposite side. At the inferior part of the neck, the eighth pair of nerves enter the thorax; that of the right side passes anterior to the subclavian artery, crossing it at a right angle; that of the left side descends anterior but parallel to the left subclavian artery. The *ninth pair,* or *lingual nerve,* leaves the cranium by the anterior condyloid hole in the occipital bone, descends forwards and inwards, nearly parallel to the digastric muscle, and is distributed to the muscles of the tongue; the arch which the course of this nerve describes is parallel, but inferior to that of the gustatory. From the convexity of this arch a long branch arises, the *descendens noni;* this descends along the forepart of the sheath of the carotid artery, communicates with the second and third cervical nerves about the middle of the neck, and is distributed to the omo and sterno-hyoid and thyroid muscles: in some cases this nerve descends within the sheath and behind the vein. The *sympathetic nerve* may be found descending along the vertebræ posterior to the carotid artery: this nerve commences at the base of the cranium, in a long, oval, red swelling, the *superior cervical ganglion,* which extends as low as the third cervical vertebra; from this the nerve, becoming very small, descends almost vertically, and in general opposite the fifth cervical vertebra it forms a second swelling, called the *middle cervical ganglion;* from this the small nervous chord continues its course down the neck, behind the sheath of the vessels, and opposite the seventh cervical vertebra, and the neck of the first rib, it expands into a large irregular swelling, the *inferior cervical ganglion,* from the lower part of which the nerve descends into the thorax. On the side of the neck are seen numerous branches of the cervical spinal nerves: there are *eight pair of cervical nerves;* the first, or suboccipital, is very small; the eighth is very large; the first leaves the spinal canal between the occipital bone and the atlas; and the eighth between the last cervical and first dorsal vertebra: these cervical nerves all divide into a posterior and anterior branch, the former are distributed to the muscles and integuments on the back of the

neck; the anterior branches of the first, second, third, and fourth, communicate with each other, and give origin to several branches, which again unite with each other, and constitute *the cervical plexus;* this plexus is between the mastoid and trapezius muscles; it sends off several branches, which are entangled with much cellular membrane, and several absorbent glands: the anterior branches of the four inferior cervical nerves, with that of the first dorsal, unite and form the *brachial plexus;* this is situated at the lateral and inferior part of the neck, and accompanies the subclavian artery beneath the clavicle into the axilla, in which region the plexus divides into several branches to supply the upper extremity and the muscles on the parietes of the thorax. In the inferior and lateral parts of the neck, on each side, the *phrenic nerve* is also seen; this arises by several fine filaments, from the third, fourth, and fifth cervical nerves; the phrenic nerve descends obliquely inwards along the anterior scalenus muscle, enters the thorax between the subclavian vein and artery, and is distributed to the diaphragm. (For the particular description of the branches of the sympathetic, as well as of the cerebral nerves, met with in the dissection of the neck, *see the Anatomy of the Nervous System.*) Previous to examining the deep muscles of the neck, the student should study the anatomy of the mouth, pharynx, and larynx.

SECTION III.

DISSECTION OF THE MOUTH, PHARYNX, AND LARYNX.

The cavity of the mouth may be exposed by dividing the commissure of the lips, and the cheek of one side, and removing a small portion of one side of the lower jaw; draw forwards and fix the tongue with a tenaculum, and cleanse the parts very well. The *mouth* is bounded anteriorly by the lips, superiorly by the hard and soft palate, laterally by the cheeks, inferiorly by the tongue, and mucous membrane reflected from it to the gums; posteriorly it communicates with the pharynx; this opening is named the *isthmus faucium,* is bounded above by the velum and uvula, below by the tongue, on each side by the arches of the palate.

Fig. 6.*

The anterior part of the palate, or *hard palate,* is formed of the palate plates of the maxillary and palate bones, covered by mucous membrane and glands; the posterior part of the palate, or *soft palate,* or *velum pendulum,* consists of a dense aponeurosis, and of several muscles and glands, inclosed in mucous membrane.

The *cheeks* are formed of mucous membrane, covered by the buccinator and a quantity of fat; several small mucous glands lie between the membrane and this muscle, and towards the upper and back part on each side we perceive the small opening of Steno's duct.

The lips are composed of integuments with more or less of fat, muscles, vessels, nerves, glands, and mucous membrane. The skin is delicate, and vascular, particularly at the red borders, where it is continuous with the mucous membrane of the mouth. The cuticle is continued over the latter to line the whole cavity as a very fine epithelium. The muscles are the orbicu-

* The cavity of the mouth. 1. The upper lip. 2. The lower lip. 3. The internal surface of the cheeks. 4. The tongue. 5. The velum pendulum palati, and uvula. 6. The œsophagus.

laris oris, with which the fibres of many others (already described) intermingle. The arteries of the lips are the coronary vessels, assisted by their inosculations with branches of the internal maxillary artery. The sentient nerves are derived from the infra-orbital and dental branches of the fifth, and the motor from the seventh pair. The labial glands are very numerous, they are rounded and pale, and are situated in the submucous loose cellular tissue, at some distance from the red border. The mucous membrane is continued from each lip to the alveolar processes of the maxillæ, and forms in the centre of each a small fold or frænum; this is larger in the upper than in the lower lip.

The mouth is lined throughout by mucous membrane, which is continuous with the cutis on the lips, and extends posteriorly through the pharynx, whence it ascends to line the nares, the Eustachian tube, and tympanum on each side, and descends to line the œsophagus and larynx; it is also continued into the ducts of the sublingual, submaxillary, and parotid glands; as it is reflected from one surface to another, it forms folds or frœna, as between the lips and alveoli, and beneath the tongue; at the sides of the fauces, also, it forms two semilunar folds on each side, called the pillars or arches of the palate; these folds inclose muscular fibres, which we shall examine afterwards.

On looking into the mouth, either in the living or dead subject, the following objects strike the attention: inferiorly the tongue and inferior teeth; laterally the cheek; posteriorly the back part of the pharynx; superiorly the superior teeth, the hard and soft palate, from the centre of the latter, the uvula, and from the sides, the pillars or arches descending to the tongue and pharynx; in the recess between these pillars on each side, the tonsil or amygdala is also seen; lastly, if the tongue be drawn forward, the epiglottis comes into view.

The *tongue*, though somewhat triangular, is of a very variable shape; its base, thick and broad, is connected to the epiglottis, and to the palate by folds of mucous membrane, the former are the fræna of the epiglottis, the latter are the arches of the palate, and to the os hyoides and inferior maxilla by muscles, to the latter also by a mucous fold, the frænum linguæ; the apex is thin and unattached; that portion between it and the base is named the body of the tongue; all the upper surface, the sides, and about one-third of its inferior surface, are covered by mucous membrane, which is very rough superiorly, from the number of papillæ that project through it; anteriorly, these papillæ are small, conical, and connected with the terminations of the nerves of taste; posteriorly, they are large, round, fungiform, lenticular, and very irregular; these are small glands which open on the mucous surface; near the epiglottis these glandular papillæ are often observed to have a peculiar arrangement, like the letter v, the concavity turned forwards; these are of a conical form, the apex attached in a little membraneous cup or calyx; behind the apex of this angle, a deep de-

Fg. 7.*

* The muscles of the inferior region of the tongue. (Gerdy). 1. The body of the os hyoides reversed by the position of the tongue upon a horizontal plane. 2. 2. Its greater cornua turned forwards instead of backwards. 3. Its appendix or lesser cornu. 4. The hyoidean aponeurosis of the genio-hyo-glossus. 5. The right hyo-glossus muscle. 6. The left hyo-glossus detached from the os hyoides and turned aside. 7. 7. Longitudinal portions of the stylo-glossus muscles. 8. 8. Posterior and inferior fibres of the genio-hyo-glossi. 9. 9. Their anterior fibres. 10. Their middle fibres. 11. 11. Section of the inferior angle of each of the genio-hyo-glossi. 12. 12. The lingualis profundus.

pression (foramen cœcum) is observable; this contains some mucous follicles; a superficial groove or raphe runs along the dorsum of the tongue, one more distinct exists along the inferior surface, and a cellulo ligamentous line divides it mesially into two symmetrical portions, this line is more distinct near the base; in some animals it is very dense and even bony; in paralysis one side of this organ is frequently found affected.* The substance of the tongue is composed of adeps blended with numerous muscular fibres derived from the stylo, hyo, genio-hyo-glossi, and lingualis muscles, and of many other fleshy fibres which do not properly belong to any of these; two large arteries, (lingual,) and six considerable nerves, (the gustatory, the lingual, and the glosso-pharyngeal, on each side,) supply this organ. The tongue is not only the organ of taste, but by its great mobility it assists in speech, in suction, and in deglutition. The fifth pair of nerves endow the tongue with sensation and with the sense of taste, the ninth with mobility, and the eighth supply its base with sensation, and connect the motions of this organ with those of the pharynx and stomach. (*See Nervous System.*)

The tongue is subject to many *morbid* changes, viz., inflammation, acute or chronic, causing a great and dangerous, and sometimes fatal enlargement; tumors of different kinds may occur in it, also ulceration, cancerous, syphilitic, apthous, &c.; portions of this organ can be removed with safety, either by ligature or excision.

SECTION IV.

DISSECTION OF THE PHARYNX.

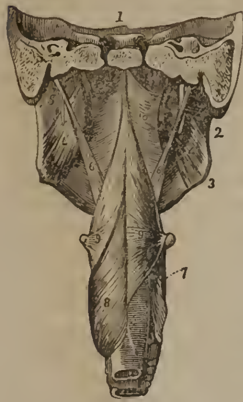
To obtain a view of the muscles of the pharynx and palate, the student may now make the following dissection: divide the trachea and œsophagus in the lower part of the neck; detach them from the vertebræ, to which they are loosely connected; draw forward these organs, together with the vessels and nerves on either side; place the saw flat on the bodies of the vertebræ; insinuate its edge between the styloid and mastoid processes on each side, and make a vertical section of the head; we have thus the face and anterior part of the cranium separated from the vertebral column; or, should it be desirable to preserve the cranium, we may separate the occipital bone from the atlas, and then remove from the subject the whole head, together with the organs we wish to examine; distend the pharynx with cotton, curled hair, or tow, and remove some of the loose cellular tissue connected to it. It is quite possible, however, for the student to dissect the pharynx from the forepart of the neck; indeed it is desirable that he should examine this organ in both these aspects.

The *pharynx* is a large, muscular, and membranous bag, extending from the base of the cranium to the fourth or fifth cervical vertebra, where it contracts and ends in the œsophagus behind the cricoid cartilage; it is placed behind, and communicates with the nose, mouth, and larynx; is somewhat of an oval form, the largest part being opposite the os hyoides, and the

* In hemiplegia, when the muscles of one side of the face are paralyzed, it has been remarked that if the tongue be protruded, the apex will be directed towards the affected side; this phenomenon, which is only an apparent exception, depends on the action of the genio-hyo-glossus muscle of the healthy side, which will pull the base of the tongue, on that side, towards the chin, and must therefore turn the point to the opposite side; but if when protruded the point be moved towards the sound side, it cannot again be pointed to the paralyzed side.

smaller extremity joining the œsophagus. The pharynx is attached superiorly and posteriorly to the cuneiform process, by an aponeurosis, which is very strong in the middle line, laterally by a thinner aponeurosis to the petrous bone, and anteriorly, by fleshy fibres, to the internal pterygoid plate and hamular process, to the posterior part of the mylohyoid ridge of the lower maxilla, and to the sides of the tongue. The pharynx is connected posteriorly to the vertebræ, and to the deep muscles of the neck, by loose reticular membrane; anteriorly, by mucous membrane and muscular fibres, to the cornua of the os hyoides and thyroid cartilage, and to the sides of the cricoid, behind which it abruptly contracts and ends in the œsophagus; on either side of it are the styloid process with its muscles, and the sheath of the carotid artery with its accompanying nerves.

Fig. 8.*



The pharynx is composed of muscular fibres, placed in successive strata of mucous membrane, and of an intervening aponeurosis, which superiorly forms, as it were, its framework for the attachment and support of the investing muscles, and the lining membrane. The *pharyngeal aponeurosis* is stronger mesially than laterally, is attached above and behind to the cuneiform process, and to the Eustachian tubes, descends mesially as a raphe or linea alba, and for about an inch and a half retains considerable strength, receiving the insertions of the constrictor muscles; laterally it is attached to each petrous bone internal to the carotid foramen and to the superior cervical ganglion by a strong band, which is continuous with the middle portion, and descending expands into different processes, of which some continue between the muscular and mucous walls of the pharynx, as low down as the os hyoides; others pass external to the superior constrictor, and are inserted, some into the pterygoid fossa, between the tensor palati and internal pterygoid muscles; others, encircling the tonsil, reach the posterior part of the inferior alveolar arch and the buccinator muscle.

The mucous membrane is continuous with that lining the mouth, nares, and Eustachian tubes, and is continued inferiorly as a lining to the larynx and trachea in front, and the œsophagus behind; it is soft, vascular, highly organized, very sensible, studded with numerous mucous glands, and covered with a fine epithelium.

The muscular fibres which cover the back and sides of the pharynx, are named constrictor muscles; they are symmetrical, and are three in number on each side; they are named the superior, middle, and inferior; they overlap each other, the inferior being most superficial, the middle next, and the superior the deepest; the constrictor muscles of opposite sides have one common insertion into the *middle tendinous line*, or raphe on the back part of the pharynx, which line is very strong and distinct superiorly, being *inserted* into the cuneiform process, but inferiorly is weak and often indistinct.

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* A posterior view of the muscles of the pharynx. 1. A vertical section carried transversely through the base of the skull. 2. The posterior border of the ramus. 3. The angle of the inferior maxilla. 4. The internal pterygoid muscle. 5. The styloid process of the temporal bone, giving attachment to 6. the stylo-pharyngeus muscle. 7. The inferior extremity of the stylo-pharyngeus muscle, attached to the superior cornu and posterior border of the thyroid cartilage. 8. The inferior constrictor of the pharynx. 9. The middle constrictor of the pharynx, partly covered on the left side by the inferior constrictor. 10. The superior constrictor of the pharynx. 11. The external surface of mucous membrane of pharynx, uncovered by muscular fibres.

Constrictor Pharyngis Inferior is of an irregular form, the anterior and inferior borders being shorter than the superior and posterior; *arises* by two heads, one from the side of the cricoid cartilage (crico-pharyngeus of some), the other from the inferior cornu and posterior part of the ala of the thyroid cartilage, external to the crico-thyroid and thyro-hyoid (thyro-pharyngeus of some); the superior fibres ascend obliquely, and overlap the middle constrictor; the inferior fibres, a few of which often arise from the trachea, run circularly and overlap the œsophagus; *inserted*, along with that of the opposite side, into the middle line or raphe on the back of the pharynx; its origin is covered by the sterno-thyroid muscle, and the thyroid gland; it lies on the mucous membrane, except its superior fibres, which are separated from it by the middle constrictor. The inferior laryngeal or recurrent nerves pass beneath its lower edge, and the superior laryngeal above its upper; the inferior head or origin is between the crico-thyroid and crico-arytenoideus posticus muscles; and the superior between and behind the attachments of the sterno-thyroid and thyro-hyoid.

Fig. 9.*

Constrictor Pharyngis Medius, or Hyo-pharyngeus (improperly called constrictor), is of a triangular form, *arises* from the cornu and appendix of the os hyoides, also from the stylo-hyoid and posterior thyro-hyoid ligaments; its fibres expand on the back of the pharynx, the superior ascend to the occipital bone, the middle run transversely, and the inferior descend beneath the lower constrictor, *inserted* in the mesial tendinous line or raphe, and into the cuneiform process. The lingual artery and hyo-glossus muscle are connected to its origin, which is separated from the inferior constrictor by the superior laryngeal nerve and cornu of the thyroid cartilage, and from the superior constrictor by the stylo-pharyngeus muscle and glosso-pharyngeal nerve; on dividing the edge of this muscle, the Stylo-pharyngeus appears; it *arises* from the root of the styloid process, descends to the side of the pharynx, where it expands between the superior and middle constrictors, and is *inserted* beneath the latter, partly into the submucous tissue, and partly into the cornu of the thyroid cartilage. *Use*, to elevate, dilate, and shorten the pharynx, and draw it slightly backwards, in order to receive the food from the tongue; it will also raise the larynx. Divide the stylo-pharyngeus, and the superior constrictor will be exposed.

Constrictor Pharyngis Superior, surrounds the superior part of the pharynx; *arises* by a dense aponeurosis from the petrous bone (which is, in fact, the lateral or bucco-pharyngeal portion of the pharyngeal aponeurosis); this soon becomes connected with the next origin, which is fleshy, from the lower part of the internal pterygoid plate and hamular process, also from the pterygo or intermaxillary ligament (see page 27), which connects it to the buccinator muscle, from the posterior third of the mylo-hyoid ridge, and from the side of the base of the tongue, between the stylo and hyo-glossus muscles; all the fibres take a semicircular course backwards and inwards,

* A lateral view of the muscles of the pharynx. 1. The zygomatic arch. 2. The external pterygoid plate. 3. The hamular process of the internal pterygoid plate. 4. The intern axillary, or pterygo-maxillary ligament. 5. A portion of the inferior maxillary bone. 6. The os hyoides. 7. The thyro-hyoid membrane or ligament. 8. The thyroid cartilage. 9. The cricoid cartilage. 10. The trachea. 11. The œsophagus. 12. The inferior constrictor of the pharynx. 13. The middle constrictor. 14. The superior constrictor. 15. The buccinator muscle. 16. The mylo-hyoid muscle.

and are *inserted* into the cuneiform process and into the middle tendinous line on the back of the pharynx. The superior constrictor is covered by the styloid muscles and by the great vessels and nerves, and inferiorly by the middle constrictor, from which the stylo-pharyngeus and glosso-pharyngeal nerve separate it; between the lateral attachments to the petrous bones and the mesial one to the occipital, the mucous membrane and fascia are uncovered by muscular fibres in a small semicircular space, named *sinus of Morgagni*; this is beneath the cuneiform process, on each side of the median line, and internal to the Eustachian tube; between the temporal and pterygoid attachments, the levator palati muscle is seen, and between the pterygoid and maxillary origins the internal pterygoid muscle and the gustatory nerve are situated. *Use*, the constrictors, particularly the upper and lower, diminish the capacity of the pharynx; the inferior can also elevate the os hyoides and tongue, and shorten the pharynx; by the successive contractions of each, the food is forced into the œsophagus; the complex muscular structure of the pharynx may also assist in the modulation of the voice and in the production of certain sounds.

Fig. 10.*

Open the pharynx by a perpendicular incision through the middle tendinous line; on looking into the cavity it will be found divided by the velum and uvula into two portions, a superior and inferior: *seven openings* also may be remarked leading from it in different directions, viz., in the upper or nasal portion there are the two posterior nares, and on the side of each of these is the opening of the Eustachian tube; below the velum is the isthmus faucium or posterior opening of the mouth; below and behind the tongue is the opening of the glottis; and lastly, the termination of the pharynx in the œsophagus.

The *openings of the nares* are of an oval shape, their long diameter being vertical; the body of the sphenoid bone bounds them superiorly, the palate bones inferiorly, the internal pterygoid plates externally, and the vomer, with a fibrous prolongation from its periosteum, separates them from each other; all these bones are covered by the mucous membrane; through these, which are permanently open, the air generally passes during respiration.

The *Eustachian tubes* open on each side of the posterior nares, behind the inferior spongy bone; they are circular, and look downwards, forwards, and inwards towards the septum narium, are formed, in two-thirds of their circumference, of thick cartilage, covered by mucous membrane; through these, air is admitted from the nose and pharynx into the tympanum, to support the membrana tympani on its inner side. The Eustachian tube must be again examined in the dissection of the organ of hearing.†

* The pharynx, laid open from behind. 1. A vertical section carried transversely through the base of the skull. 2. 2. The walls of the pharynx drawn to each side; on the right side the mucous membrane has been removed, in order to show the internal surface of 3. The superior constrictor, and 4. The middle constrictor. 5. The palato-pharyngeus muscle. 6. 6. The posterior nares separated by the vomer. 7. The levator palati. 8. The vertical portion of the circumflexus palati. 9. The extremity of the Eustachian tube of the right side. 10. The isthmus faucium. 11. The base of the tongue. 12. The epiglottis, and beneath it the superior opening of the larynx. 13. The commencement of the œsophagus 14. A portion of the internal pterygoid muscle.

† The student may practise the introduction of a probe into this tube; slightly curve a blunt probe, pass it along the floor of the nose to the posterior nares, then direct its extremity upwards, outwards, and backwards, that is, towards the ear, and it will enter this tube.

Beneath the velum is the *isthmus faucium*, transversely oval, but capable of great change in figure and size, bounded above by the velum and uvula, below by the tongue, and on either side by the *pillars or arches* of the palate, and by the amygdalæ.

The opening of the *glottis*, or *superior* opening of the larynx, is at the lower and anterior part of the pharynx, behind the epiglottis, and rather beneath the tongue; it is of a triangular form, the base anteriorly formed by the epiglottis; the sides are composed of folds of mucous membrane, termed aryteno-epiglottidean, and the apex, which is posteriorly and a little notched, is formed by the appendices of the arytenoid cartilages; the sides are somewhat thickened and strengthened by two small fibro-cartilages inclosed between the mucous folds (cuneiform cartilages or bodies). The glottis, which will again be considered in speaking of the larynx, is always open, except in the act of deglutition. The *œsophageal opening* is below and behind the glottis; it is always closed, except in deglutition. The student should next examine the velum pendulum palati, or palatum molle.

SECTION V.

DISSECTION OF THE PALATE AND ITS MUSCLES.

The *velum pendulum palati*, or *palatum molle*, is a soft, movable partition, or valve, extending in a gentle curve the surface of the arched roof of the mouth, and the inclined plane of the nares, and separating the mouth and fauces from the nasal or superior region of the pharynx; quadrilateral, its anterior and superior border, which is thick and strong, is firmly attached to the posterior part of the hard palate; its posterior inferior margin is thin and concave, bounding the isthmus faucium; from its centre a conical appendix (uvula) descends, and thus divides this margin into two slightly lunated portions, named by some the *half arches* of the *palate*. Its lateral limits are marked by a prominent ridge leading from the posterior part of the superior alveolar arch to that of the inferior one; this ridge nearly corresponds to the anterior border of the internal pterygoid muscle, and contains a number of small mucous glands; these are often collected into a distinct, round cluster behind the last inferior molar tooth. The velum, when at rest, is placed obliquely; near the hard palate it is horizontal, but towards its free margin it is curved downwards, so that the inferior or oral surface is concave, the superior convex; on the former a dense, pale line continued from the raphe on the hard palate marks it mesially and divides it into two symmetrical portions; this surface looks downwards and forwards towards the tongue; the opposite surface, also marked by a mesial raphe, but more prominent on either side, looks upwards and backwards; during life these aspects are constantly being changed by the action of the muscles, which can depress, elevate, and make tense the velum. The *uvula* is a conical prolongation of the mucous membrane of the velum, a sort of *cul de sac*, containing some muscular fibres superiorly, glands and cellular tissue inferiorly; it hangs perpendicularly over the depression in the tongue, called foramen cœcum, is not in contact, but so very close that nothing of any size can pass between them without affecting the sensibility of the uvula, whereby all the surrounding muscles are excited to action; the point of the uvula is anterior to the epiglottis. This organ is very variable as to shape and size, it is sometimes a little bifid, sometimes nearly absent, and is wanting in almost all other mammalia, except the ouadrumana. From either side of the uvula the mu·

cous membrane of the velum is continued downwards in two folds, which contain muscular fibres, and are named the *arches* or *pillars* of the palate. The anterior arch or fold, passing from the base of the uvula, is curved downwards and outwards, and ends on the superior and lateral part of the tongue; this fold is very concave inwards, and contains the palato-glossus or constrictor isthmii faucium muscle. The posterior arch or fold arises near the point of the uvula, and is continued in a curved form from the free edge of the velum downwards, outwards, and backwards, and is lost in the side of the pharynx; it contains the palato-pharyngeus muscle, and is on a plane internal as well as posterior to the former; both these folds are somewhat triangular, the apex above, the base below, and as they diverge inferiorly, they leave a considerable space between them, in which the amygdala or tonsil of each side is lodged. This tonsilitic recess or ventricle is narrow and pointed above, broad and deep below, bounded before and behind by the arches of the palate, below by the base of the tongue and the mucous membrane passing from the pharynx to the epiglottis; it corresponds externally and inferiorly to the angle of the jaw and to the integuments over the posterior part of the sublingual region. The velum is a highly organized structure, it is composed of a duplicature of mucous membrane, inclosing glands, cellular tissue, nerves, and vessels, a strong aponeurosis forming the basis of general support, and several muscles designed to move it in different directions, namely, to elevate, depress, and make it tense. It is of great use in deglutition and in the modulation of the voice; when depressed it comes into close contact with the tongue and closes the mouth posteriorly; when elevated during the contraction of the pharynx it may touch the latter so as to separate or shut off the nasal division, and thus during deglutition or in vomiting prevents the food ascending into it and regurgitating through the nares and Eustachian tubes, its aponeurosis and tensor muscles regulate and restrict these motions and impart the necessary strength and resistance.

The mucous membrane is continued from that of the hard palate, round the thin edge, to the upper surface, and is continuous with that covering the floor and septum of the nose; the laminæ are in much closer apposition in the lunated borders of the free margin than in other situations; a digital prolongation from the centre is produced downwards to constitute the uvula; the lower surface is soft and vascular, resembling that in the adjacent regions, the upper, like that on the floor of the nose, is paler and thinner; the mucous glands are but few above, but on the oral surface they form a thick, submucous layer, which is prolonged for a variable extent into the uvula. The palatine aponeurosis is very strong and laminated; an inferior, weaker layer is continued from the hard palate, the submucous glands are intimately connected to it; above this is a much stronger aponeurosis, formed partly of the expanded tendons of the tensor muscles, and partly of the fibrous tissue from the septum narium and adjacent bones. The muscles of the velum or soft palate are five pair, the levator and tensor palati, the motor uvulæ, palato-glossus, and palato-pharyngeus.

Levator-Palati, thick and round, *arises* narrow from the petrous bone, in front of the foramen caroticum and behind the Eustachian tube, descends obliquely inwards, and is *inserted* broad into the velum near its centre; its name denotes its *use*. It is situated on the side of the posterior nares, covered internally and posteriorly by mucous membrane, and externally by the tensor palati and superior constrictor; its insertion intermixes with its fellow, with the other muscles of the palate, and with the palato-pharyngeus.

Tensor Palati vel circumflexus palati, thin and slender, *arises* fleshy from a depression at the root of the internal pterygoid plate, from the spinous process of the sphenoid, and from the forepart of the Eustachian tube, descends between the internal pterygoid plate and muscle, ends in a flat tendon,

which turns round the hamular process inwards to the velum; it then expands, and is *inserted*, with that from the opposite side, into the horizontal plate of the palate bones, and into the palatine aponeurosis. *Use*, to make tense the velum in a horizontal direction between the hamular processes; it may possibly dilate the Eustachian tube.

Motor Uvulæ, *arises* from the posterior extremity, or spine of the palate bones, or rather from the palatine aponeurosis, or fibrous continuation of the septum narium; descends close to its fellow along the median line of the nasal surface of the velum, and is *inserted* into the cellular tissue of the uvula. *Use*, to raise and shorten the uvula: this pair of muscles are so close that they appear but as one, hence they have sometimes received the name of *azygos uvulæ*.

Palato-Glossus vel constrictor isthmi faucium, or the anterior arch or pillar of the palate, semilunar, narrow in the centre, broad at its extremities, *arises* from the inferior surface of the velum, descends a little forwards and outwards, inclosed in a fold of mucous membrane anterior to the tonsil; *inserted* into the side of the tongue, intermingling with the stylo-glossus. *Use*, to elevate the tongue or to depress the velum; this pair of muscles may also close the fauces.

Palato-Pharyngeus, or posterior arch of the palate, *arises* broad from the inferior surface of the soft palate in common with its fellow; arches downwards and backwards behind the tonsil, and is *inserted* into the side and back of the pharynx, and into the cornu of the thyroid cartilage, its fibres mixing with those of the stylo-pharyngeus; both this and the palato-glossus muscle are narrower in the centre than at their extremities. *Use*, to elevate the pharynx, like the stylo-pharyngei in the commencement of deglutition, also to depress the velum, but chiefly to approximate the sides of the fauces, and bring them, the tongue, and velum into contact.

The *tonsil*, or *amygdala*, though apparently a compact body, is formed of a congeries of mucous glands, of an irregular figure, somewhat oval, the larger extremity above, placed in a triangular recess between the pillars of the palate, above the side of the base of the tongue, and opposite the angle of the jaw; covered internally by the mucous membrane, and externally by a fascia and by the superior constrictor of the pharynx; small holes are remarked on its surface; these lead into interlobular cells from which the mucus can be expressed. The amygdalæ are very vascular and secrete a viscid fluid, which being pressed out in the moment of deglutition by the contraction of the surrounding muscles, *serves* to lubricate the alimentary bolus in its passage. The internal carotid artery is superior and somewhat external to it, and, when tortuous, very near to it; the external carotid is also to its outer side, and the facial artery, just before it enters the submaxillary gland, is anterior to it; from these three vessels this gland, when of its healthy size, is separated by the superior constrictor, and by a considerable interval which is filled by cellular tissue, but when enlarged, as in the case of abscess, it comes into such close contact with these, particularly with the internal carotid, that there is some danger of wounding the latter in opening the abscess with the lancet.

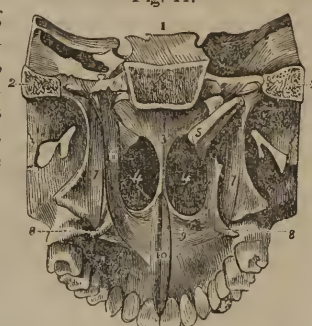
The group of muscles now described, though in a great degree voluntary, yet rather belong to the mixed class; the will can excite and control them only to a certain extent, it can even continue their actions for a time, but if there be no substance to be swallowed, their contractions cannot be often repeated, and volition is impotent; they act, too, convulsively, and oftentimes without any cognizance; deglutition occurs in sleep: the volition power is most enjoyed anteriorly, as in the tongue, lips and cheeks; the mixed property prevails in the middle region: the lower we descend the more involuntary is the muscular fibre, and so it is at the opposite or lower end of

the alimentary canal, the mixed property and the volition power of the investing and surrounding muscles are gradually developed towards the orifice, while all the intervening muscular coat of the digestive tube is purely involuntary; perhaps the muscular powers of the stomach, in some animals at least, may prove an exception to this general assertion. The sensibility to contact of the mucous membrane in the palatine region is very considerable, and exerts a rapid influence over the surrounding muscles through the reflex motor power of the nervous system, whereby the act of *deglutition* is effected; this act, though momentary, and, as it were, convulsive, may be divided into three stages; in the FIRST, which is in part only a continuation of mastication, the alimentary matter is pressed by the convex surface of the tongue, which is accurately and beautifully moulded to the vault of the palate, backwards into the space bounded by the anterior arches or pillars of the velum, that is, into the isthmus faucium; during this stage the velum is depressed, and lies nearly in contact with the base of the tongue, the pharynx is in a state of rest; this stage is accomplished chiefly by the muscles of the tongue and cheeks; in the first instance the mouth is closed anteriorly, and the last agent is the constrictor isthmus faucium; it is a voluntary act. In the SECOND stage, the alimentary matter is carried through the fauces and pharynx into the œsophagus; the velum at first is made tense and slightly raised; the tongue is retracted, the larynx drawn upwards beneath it so that the epiglottis is pressed or shut down over the glottis, and the alimentary mass glides over its centre and sides; at this very instant the pharynx is advanced, its sides approximate, the velum descends a little, though still preserving the partition below the nares, and is held steady; all the muscles now contract towards the base of the tongue, and thus a narrow inclined passage or chink conducts the food down to the œsophagus; finally, the still contracting pharynx recedes; and, last of all, the larynx descends coincident with the entrance of the morsel into the opening of the œsophagus. This stage is effected not only without the influence of the will, but even at times in opposition to it, although it may, and does, occasionally exert some power of control so as to retard, hurry, or even interrupt it. In the THIRD stage, the food descends along the œsophagus into the stomach by rapid, undulatory contractions, each portion of the tube first dilating to receive, and then contracting to propel, somewhat analogous to the peristaltic action of the alimentary canal, and like that, too, wholly involuntary, and scarcely even giving rise to any sensation, unless the mass swallowed should be of inordinate magnitude, or of a temperature extremely high or even very low, or unless the act be too rapidly repeated. Not only is the velum essential in deglutition, but it is also most usefully concerned in certain conditions of respiration, thus in suction it is indispensable; in forced inspiration through the mouth, it is raised and made tense, and thus the whole of the air imbibed must descend into the chest, as none can enter the Eustachian tubes, or escape by the nares. In the modulation of the voice, the expression of sounds, words, and letters, it also acts an important part; by being raised or depressed, made tense or loose to the requisite degrees, it produces the desired effect, and hence not only the difficulty of deglutition, but also the peculiar altered tone and indistinctness of voice and utterance when this organ is cleft or otherwise abnormal from original malformation or arrest in its development, or when it has become perforated by ulceration, condensed and shrivelled by disease, or partially destroyed by gangrene. The mucous membrane of the velum and adjacent surfaces enjoys a certain degree of taste for peculiar substances, and is also exquisitely sensible to certain pungent, disagreeable, and noxious odors, and the irritability of all the surrounding muscles is thereby rapidly excited, through the reflex power of the nervous system, to active and repeated contractions, not so much in their ordinary as

in a retrograde order, so as to lead to the rejection or expulsion, aided by forcible expiration, of the offending substance, and thus by this endowment the lungs and stomach are wonderfully guarded against the admission of injurious or dangerous agencies. In these various offices of the velum, it is not easy to affirm the use of the uvula; its muscle may stiffen and strengthen it when the palate is raised or tense, or when the latter is depressed, it may in a passive manner contribute to narrow the chink-like passage for the food; however its variable and even occasional arrest of development, and not unfrequent removal in man without any corresponding deficiency, together with its total absence in most of the animal kingdom, preclude the idea of its being of any essential utility in a function so universal as is that of deglutition; it may, no doubt, aid the velum in perfecting those modulations and expressions of voice already alluded to. It is very sensible to contact, and irritable, and all the surrounding parts very quickly sympathize with it; from its depending position, and the proximity of its apex to the base of the tongue, not even the thinnest stratum of fluid can glide between the two, without exciting the sensibility of the uvula, and thence the irritation is rapidly conveyed to all the muscles concerned in the second stage of deglutition; it thus appears to act as a sort of sentinel in this important and critical position, and as deglutition of the salivary secretions constantly occurs at intervals during sleep, which man usually enjoys in the horizontal or reclined position, it may not, perhaps, be amiss to conceive that the superior development of this appendix in him has reference to that condition.

A careful examination of all this curious and complicated palatine and pharyngeal apparatus will explain the mechanical arrangements which have been so ingeniously designed and so perfectly executed for the safe and frequent performance o functions so necessary to life; how the air can freely pass, during sleeping as well as waking hours, to and from the lungs, as also into each tympanum, without descending into the stomach, and how all alimentary matters, solid as well as fluid, are in safety propelled over the glottis into the œsophagus by the rapid, convulsive efforts of numerous concurring muscles, with only a momentary interruption to respiration, as this function, that is, the mechanical acts of inspiration and expiration, must be suspended during the instant in which the second stage of deglutition is being performed.

Fig. 11.*



The soft palate and its arches, the uvula and the tonsils, are liable to many *morbid* affections, viz., acute inflammation and all its consequences; syphilitic ulceration very commonly attacks these parts, particularly that surface towards the mouth; polypi, also, are not unfrequently produced from the velum, and in general from its upper or nasal surface. When the uvula is the seat of inflammation, its pendulous extremity becomes so distended by serous infiltration that its figure is totally changed, and it sometimes interferes so

* The muscles of the soft palate. 1. A transverse section of the skull, passing through the basilar process of the occipital bone in the centre, and through, 2. The posterior part of the great wing of the sphenoid. 3. The vomer covered by mucous membrane, and forming the posterior part of the septum of the nasal fossæ. 4. The posterior nares. 5. The Eustachian tube. 6. The levator palati muscle. 7. 7. The tensor or circumflexus palati. 8. 8. The hamular process, round which the tensor palati turns. 9. The horizontal portion of the tensor palati, expanding in the structure of the soft palate. 10. The motor uvulæ descending from the posterior spine of the palate bones.

much with deglutition and respiration, or excites such irritation, as to require free scarification, or excision of its lower portion. The velum is sometimes found cleft at birth with or without the accompanying similar abnormal state of the hard palate and upper lip.

The tonsil is very subject to acute inflammation (cynanche tonsillaris); in this affection it enlarges so much as to impede deglutition, induce deafness, and even in some cases to threaten suffocation. It is sometimes, also, the seat of chronic enlargement, to such a degree as to require the operation of removal; it is also frequently affected with syphilitic ulceration, also with calcareous deposit; its cribriform surface, when covered with lymph, should not be mistaken for ulceration.

The *œsophagus* appears as the continuation of the pharynx, it differs from it, however, in structure; the mucous membrane is paler, and thrown into longitudinal folds; the muscular fibres are arranged in two laminæ; the external are longitudinal, strong, and red, attached superiorly and anteriorly to the cricoid cartilage, and below are lost on the stomach; the internal circular fibres are pale, and cease abruptly at the cardiac orifice of the stomach; in the neck the œsophagus descends posterior to the trachea, and nearly in the middle line; it inclines a little to the left side below, so as to be uncovered by that tube; in the upper part of the thorax it inclines a little to the right, and below again to the left. This slightly tortuous, intestine-like course, might offer some impediment to the passage of a bougie: the left lobe of the thyroid gland, the recurrent nerve, and the inferior thyroid vessels, lie on it in this situation; it is flattened in the neck, and rounded in the back, is wider below than above.

The *morbid* appearances met with in the pharynx and œsophagus are not very many; the mucous membrane of the former is liable to inflammation (cynanche pharyngea), and to ulceration from various causes; the submucous tissue is frequently the source of polypous growths, particularly at the upper part. The lining membrane of the œsophagus is seldom the seat of active inflammation, except as the consequence of some foreign body, or the contact of some acrid substance; it is not unfrequently the seat of stricture, caused in some cases by a contraction and thickening of its coats, in others by true scirrhus, ending in cancerous ulceration; tumors in the vicinity of this tube will also interrupt its functions, for example, bronchocele, enlarged bronchial glands, or aneurism of the descending aorta. The œsophagus is also sometimes affected with paralysis, and in hysterical patients it is very subject to nervous affections, which frequently bear a close resemblance to true stricture of this tube. The course and connections of the œsophagus in the chest will be seen hereafter.*

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* The student should practise the passing of a probe or canula armed with a ligature, along the nares, into the pharynx, and endeavor to inclose the uvula in the noose, thus imitating the operation of tying polypi when situated in the pharynx, on the velum, or in the posterior nares; he may also pass a flexible tube into the pharynx, and thence direct it to the stomach or into the larynx. Any practitioner may be suddenly called on to use the stomach pump in case of poison having been swallowed or to inflate the lungs in asphyxia; in the *first case*, when the tube has passed into the pharynx, from the mouth or nares, the tongue should be pressed back, so as to close the glottis, and the end of the instrument should be kept close to the vertebræ to avoid irritating or pressing on the epiglottis; in the *second case*, the tube should be passed through either naris into the pharynx, the forceps or the finger of the surgeon, introduced into the mouth, can then guide it downwards and forwards to the glottis; at this time, however, the tongue should be drawn forwards; thus the epiglottis will be raised, and the glottis opened opposite the edge of the velum; the tube may then be urged into the larynx, and artificial respiration commenced. In conducting this process it is advisable to press the upper part of the trachea gently against the vertebræ, so as to fix the larynx and the tube, as well as to guard against the admission of air into the œsophagus, and the consequent inflation of the stomach.

SECTION VI.

DISSECTION OF THE LARYNX.

The *larynx* surmounts the upper extremity of the respiratory passages with which it communicates below, as it does with the pharynx above; it is composed of a complicated apparatus of several cartilages, muscles, and ligaments, which constitute the organ of voice; is placed at the anterior part of the neck, between the tongue and trachea, in front of the pharynx and œsophagus, covered only by the integuments and the subhyoidean muscles; it is suspended by muscles and ligaments from the os hyoides. Although this bone does not, strictly speaking, appertain to the larynx, but rather to the tongue, yet the former is so connected with it, that this appears a fitting situation to examine it.

The *os hyoides* is connected to the chin by several muscles, and to the styloid process of the temporal bone on each side by the digastric and stylo-hyoid muscles and ligament; it consists of five parts; the middle portion, or *body*, is very rough, and convex anteriorly and superiorly for the attachment of muscles, concave posteriorly and inferiorly, where it covers the epiglottidean submucous tissue; from the body the cornua pass off, one to either side, giving attachment to muscles above and below, and lined by mucous membrane; they serve to expand the pharynx and fauces; where each cornu joins the body a small process, the *appendix*, ascends obliquely backwards, and gives attachment to the stylo-hyoid muscle and ligament. It sometimes happens that this ligament is ossified, so that the os hyoides will then be found attached to the cranium.

In examining the different structures which enter into the formation of the larynx, I shall pursue the following order: 1. the cartilages, with their ligaments and articulations; 2. the muscles; 3. the mucous membrane and glands; 4. the vessels; 5. the nerves; and, finally, offer a few general observations on this organ. Four true, or perfect, and four false, or imperfect, cartilages, enter into the formation of the skeleton of the larynx; the true cartilages are the thyroid, cricoid, and two arytenoid; the false cartilages are the two corpora cuneiforma, and the appendices or cornicula of the arytenoid cartilages; there is also one fibro-cartilage, the epiglottis.

Fig. 12.*

The *thyroid*, or shield-like cartilage, is placed at the anterior and lateral parts of the larynx; it embraces the sides and back part of the cricoid, and protects the greater part of the mechanism of the larynx, but is open behind; it is composed of two broad, irregularly-shaped lateral plates or alæ, which join in an anterior angle or prominence in the mesial line; this is more developed in man than in the female or child, and is named the *Pomum Adami*. As each ala passes backwards it increases in depth, and presents two tubercles, one near the superior, the other smaller near the inferior margin; an oblique ridge connects these, and divides the ala into two unequal segments, of which one is anterior and superior, and much larger than the other, which is behind and below this line.

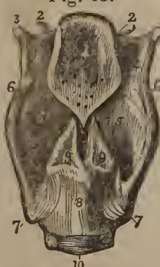
* A lateral view of the larynx, the muscles having been removed. 1. The body of the os hyoides. 2. Its appendix or lesser cornu. 3. Its great cornu. 4. The superior extremity of the epiglottis. 5. The hyo-thyroid ligament or membrane. 6. The thyroid cartilage. 7. The cricoid cartilage. 8. The upper part of the trachea.

This ridge gives attachment to the sterno-thyroid, hyo-thyroid, and inferior constrictor muscles; near the upper tubercle is a notch, or often a foramen, for the transmission of the superior laryngeal nerve. The upper border of each ala is convex, and gives attachment to the thyro-hyoid membrane; it is deeply notched in front above the pomum. The inferior border is shorter, and nearly horizontal, and projected a little below the pomum, giving attachment to the elastic crico-thyroid ligament: posteriorly this border is arched deeply. The alæ are round and thick posteriorly, giving attachment to muscles and the mucous membrane of the pharynx, and resting against the vertebral column: from the upper and lower edge of each are continued the cornua. The superior or ascending cornua are long and round, and are connected to the os hyoides by round ligaments, which are often studded with cartilaginous and osseous grains. The inferior cornua are short, and bent a little inwards and forwards, and are articulated to the oblique surfaces on the cricoid cartilage. Each ala is concave internally, and covers the thyro-arytenoid, and the lateral crico-arytenoid muscles. The posterior surface of the pomum is very concave, and gives attachment in the mesial line to the ligament of the epiglottis, and on each side to the chordæ vocales.

The *cricoid* or annular cartilage forms the lower part or base of the larynx, it is very thick and strong; it is not perfectly circular, but rather elliptical, narrow before, deep and strong behind; the inferior edge or circumference is nearly circular and horizontal, and connected by an elastic structure and mucous membrane, to the first ring of the trachea, than which it is thicker and deeper. The anterior and external surface is convex, and gives attachment to the crico-thyroid muscles, posterior to which is an articulating tubercle on each side for the inferior cornu of the thyroid cartilage. The superior margin is oblique, being bevelled from below and before, upwards, backwards, and a little inwards; anteriorly there is a space between this border and the thyroid cartilage, occupied by the elastic crico-thyroid ligament; the posterior part of this upper margin is horizontal, having on each side a smooth convex surface, looking upwards and outwards for articulation with the bases of the arytenoid cartilages. The posterior surface is nearly four times deeper than the anterior, and is divided by a middle vertical prominent ridge, to which some fibres of the œsophagus are attached; on each side of this is a depression which is occupied by the crico-arytenoid postici muscles. The internal surface of this cartilage is smooth, and lined by the mucous membrane.

The arytenoid, or ewer-shaped cartilages, are situated vertically on the articulating surfaces on the upper and posterior border of the cricoid; they are somewhat pyramidal or triangular; the base of each is below deeply curved into an oval, oblique, articulating surface, with two processes, one external for the attachment of the crico-arytenoid muscle, the other is anterior, for the insertion of the inferior chorda vocalis, which forms the side of the rima glottidis; this latter prominence is pyramidal, it projects considerably over the side of the rima, nearly one-third of its extent. The apex of each arytenoid inclines a little backwards, and is surmounted by the *appendix* or *corniculum*. The posterior surface is concave, and covered by the arytenoid muscle. Anteriorly each is convex, with sharp, rugged ridges for the insertion of the

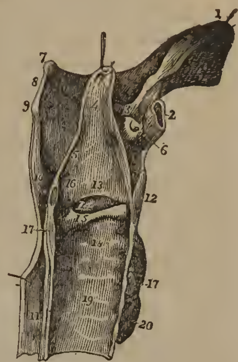
Fig. 13.*



* A posterior view of the larynx, after the removal of its muscles. 1. The posterior surface of the epiglottis. 2. 2. Appendices or lesser cornua of the os hyoides. 3. 3. The great cornua of the os hyoides. 4. 4. The posterior surface of the hyo-thyroid ligament. 5. 5. The posterior surface of the thyroid cartilage. 6. 6. The ascending cornua of the thyroid cartilage. 7. 7. Its inferior cornua. 8. The cricoid cartilage. 9. 9. The arytenoid cartilages. 10. The first ring of the trachea.

superior chorda vocalis, and the aryteno-epiglottidæan folds of mucous membrane which form the side of the glottis; these ridges are, of course, superior to the basilar projections into which the inferior chordæ vocales are inserted. Their internal or opposed sides are flat and smooth, and covered by mucous membrane, so as to admit of their approximation. These cartilages enjoy free motion in the four directions, forwards, backwards, inwards, and outwards, as well as a certain degree of rotation round the axis of their articulations on the cricoid.

Fig. 14.*



The *appendices* or *cornicula* of the arytenoids are two small, curved, cartilaginous bodies, described by Santorini, inclining backwards and towards each other, loosely joined to the apex of each arytenoid, which they serve to lengthen in the vertical direction, and on which they can freely move.

The *epiglottis* stands behind the base of the tongue, nearly erect, in front of the opening of the glottis, over which it can, however, be bent almost horizontally, so as to cover this opening during deglutition. It is considered as a fibro-cartilage, but it is really a complex structure, and may be regarded as one *sui generis;* in form it is somewhat triangular or oval, its edges being curved or curled, so as to resemble a cordate leaf: its color is a pale yellow, with little appearance of vascularity; anteriorly it is curved forwards above and a little along its edges, so as to be concave from above downwards, and convex transversely, while posteriorly it is convex from above downwards, and concave transversely. The anterior or lingual surface is free superiorly, and can be seen and felt in the living mouth; inferiorly this surface is adhering to the base of the tongue, os hyoides, and thyroid cartilage; to the tongue by an elastic tissue, glosso-epiglottic ligament, which is below the mucous frænum; to the os hyoides by a thin ligament (hyo-epiglottic,) extending from the upper and posterior edge of the base of that bone to the forepart of the epiglottis, and beneath this by a mass of cellulo-adipose matter of a yellowish color, very soft, mobile, and somewhat elastic, and surrounded by loose cellular tissue very like a synovial bursa; this mass has been very generally called "epiglottic gland," but on insufficient grounds, for careful examination does not disclose any glandular structure or ducts extending to the mucous surface; in the young subject I have often found a lymphatic gland in this position, and in delicate children I have frequently met with a small tumor here, and suppuration is by no means uncommon in this locality, and is occasionally very dangerous. The epiglottis is attached inferiorly by a stalk-like pedicle (not visible without dissection) to the inside of the pomum, immediately above that of the true chordæ vocales; this pedicle is ligamentous, (thyro-epiglottic ligament,) and much thinner and more delicate than the leaf itself; the centre of the upper border is slightly notched, and perfectly free; anteriorly, latterly, and posteriorly it

* A vertical section of the larynx. exhibiting the interior of the left half. 1. A portion of the base of the tongue. 2. The section of the body of the os hyoides. 3. The frænum epiglottidis. 4. The left half of the epiglottis. 5. The aryteno-epiglottidæan fold of mucous membrane. 6. A section of the epiglottidæan gland. 7. The great cornu of the os hyoides. 8. The hyo-thyroid ligament 9. The ascending cornu of the thyroid cartilage. 10. The mucous membrane of the pharynx. 11. The cavity of the œsophagus. 12. A section of the thyroid cartilage. 13. The superior vocal chord. 14. The sinus or ventricle of the larynx. 15. The inferior vocal chord. 16. A prominence produced by the left arytenoid cartilage. 17. 17. Sections of the cricoid cartilage. 18. The internal surface of the cricoid cartilage, lined by mucous membrane. 19. The internal surface of the trachea 20. A section of the thyroid gland.

is connected to the tongue, pharynx, os hyoides, and arytenoid cartillages by folds of mucous membrane, which are individually named from their attachments. The mucous membrane is loosely connected to it in front, but closely behind; on this latter aspect many small foramina are observable, which are probably orifices of mucous ducts; these are much more obvious in some than in others, and are more distinct in some of the ruminantia than in man. If the mucous membrane be dissected off this surface, these, as well as other foramina are observed perforating this plate; the holes are surrounded by a dense cartilaginous tissue, and through these some bands of elastic, yellow tissue, intermingle. The epiglottis is very flexible, and eminently elastic, thus it is easily depressed in deglutition, and its elevation is rapid, not requiring any muscular action, when once the tongue has advanced, and the larynx descended. It is never found ossified, a change which the other cartilages of the larynx, particularly the thyroid and cricoid, are very prone to undergo. In deglutition the epiglottis is of much use, it covers the larynx, and so prevents any foreign substance entering it; during this act the tongue is drawn backwards, and the larynx raised forwards, thus the glottis is closed, and the contents of the mouth pass over the epiglottis into the pharynx. The *cuneiform* are two small, irregularly-shaped bodies, somewhat triangular, the base above involved in the aryteno-epiglottidæan folds of mucous membrane, near to the apices of the arytenoid cartilages; in some they are very indistinct, and look like a small glandular or adipose mass; in others they are firm and prominent, and, when separated from the investing tissue, have somewhat the form of the letter L; they serve to strengthen and thicken the sides of the glottis.

The larynx is articulated, or rather connected to the os hyoides by three *hyo-thyroid ligaments*, one middle and two lateral; the anterior is a broad, yellow, but loose tissue, arising from the superior margin of the thyroid angle, and inserted into the inner margin, and superior edge of the base of the os hyoides, and not into its lower, it is therefore behind that bone; it is covered by the integuments in the centre, and on each side by the thyro-hyoid muscles, and is separated from the epiglottis by the adipose mass. The lateral thyro-hyoid ligaments are round cords which connect the superior cornua of the thyroid cartilage with the round tubercles at the extremities of the cornua of the os hyoides, these occasionally contain cartilaginous or osseous grains. The thyroid cartilage is articulated by its inferior cornua, to the oblique surfaces on the cricoid, which look upwards and outwards, these are arthrodial joints and possess synovial membranes, and capsular ligaments, the fibres of which are very distinct and bright, radiate to some extent, particularly behind, nearly reaching the crico-arytenoid articulations. In these joints, there is a slight gliding motion, and a very palpable rotary one round the transverse axis of both. The middle crico-thyroid is an important ligament, very strong, yellow, and elastic, arising from the lower border of the thyroid, and *inserted* into the upper edge of the cricoid; two or three minute pores exist in it for the passage of small bloodvessels. Strong ligamentous fibres also connect the sides of these two cartilages by their internal borders. The crico-arytenoid articulations are furnished with loose synovial membranes, and secured by strong crico-arytenoid fasciculi of ligamentous fibres; the surface of the cricoid is convex, that of the arytenoid concave; great freedom of motion exist in these articulations. The *thyro-arytenoid* ligaments or chordæ vocales are four in number, two on each side, a superior and inferior. The inferior are true fibrous chords, much stronger than the superior, which are little more than folds of mucous membrane; they *arise* from the angle of the thyroid, extend horizontally backwards on each side of the long axis of the rima glottidis, and are *inserted* into the anterior or long pyramidal process at the base of each arytenoid cartilage; the thyro-arytenoid muscles are closely

Fig. 15.*

nected to their outer side, and impart much of their apparent thickness, while their inner, upper, and lower are smooth and free to vibrate in the opening; these are strong and semi-transparent ligaments, and composed of parallel and elastic fibres; they are longer in the male than in the female, and very short in the child. The superior chordæ vocales or thyro-arytenoid ligaments, are by some named false ligaments; they are thinner, weaker, and further removed from the axis of the larynx; they *arise* above the former, pass backwards in an arched course, concave downwards, and are *inserted* into the anterior superior part of the arytenoid; they consist of a few delicate fasciculi of elastic fibres, involved in mucous membrane; their superior border is not defined, but the inferior is, as it forms the top of the sinus of ventricle of the larynx. The ligaments of the epiglottis are the thyro-epiglottidæan, or the stalk-like connection to the thyroid cartilage; the hyo-epiglottidæan, which is a thin membrane passing horizontally from the upper edge of the base of the os hyoides to the forepart of the epiglottis; the epiglottis is also connected to the anterior and lateral parts of the pharynx on each side by a fold of mucous membrane, and to the base of the tongue by three similar folds, of which the centre (frænum epiglottidis) is the strongest, it contains a little dense cellular tissue, a few elastic fibres, and is also slightly *inserted* into the os hyoides, above the hyo-epiglottic ligament. The cricoid cartilage is connected to the trachea by an elastic ligamentous tissue which, though very strong, admits of free motion in all the movements of the neck; this ligament is stronger in front; it is very similar to that connecting the several rings of the trachea to each other.

The muscles of the larynx are symmetrical; they are found on the front, sides, and backpart, those on the forepart are the thyro-hyoid, and crico-thyroid, on each side are the thyro and lateral crico-arytenoid, and posteriorly are the arytenoid and posterior crico-arytenoid; to these some add the thyro-epiglottidei and the aryteno-epiglottidei.

Thyro-Hyoideus, broad and flat, *arises* from the upper edge of the oblique ridge on the ala of the thyroid cartilage, ascends a little outwards, and is *inserted* into the lower border of the cornu of the os hyoides. *Use*, to elevate and draw forwards the larynx beneath the tongue and epiglottis, and so cause the glottis to be closed in deglutition. This muscle is partly covered by the integuments and sterno and omo-hyoid; it appears like a continuation of the sterno-thyroid.

Crico-Thyroideus, inferior to the former, short and triangular; *arises* narrow from the forepart of the cricoid cartilage, ascends obliquely outwards and backwards, and is *inserted* broad into the lower border and cornu of the thyroid. *Use*, to approximate these cartilages, and, at the same time, to rotate the cricoid on the thyroid; that is, they depress and draw forward the thyroid, and raise and tilt backwards the cricoid cartilage, and thus make tense the chordæ vocales. The crico-thyroid ligament occupies the space between these muscles; they are covered by the sterno-hyoid. Raise the ala of the thyroid cartilage on one side, and the lateral muscles of the larynx will be exposed.

Thyro-Arytenoideus is flat and thin; *arises* from the internal surface of the thyroid cartilage, near its angle; the fibres pass backwards and outwards, expanding over the side of the rima glottidis, and are *inserted* into the ante-

* A view of the larynx from above downwards, to show the form and relative dimensions of the rima glottidis; the os hyoides and hyo-thyroid ligament have been removed. 1. 1. The upper border of the thyroid cartilage. 2. 2. Its ascending cornua. 3. 3. The chordæ vocales. 4. The rima glottidis. 5. 5. The apices of the arytenoid cartilages. 6. The cricoid cartilage.

rior and outer edge of the arytenoid cartilage, and into the outer side of its long anterior process; some fibres pass partly round this border to the posterior surface. *Use,* to draw the cartilage downwards and towards its fellow, thereby diminishing the capacity of the rima glottidis; these muscles can also produce various alterations in the form, position, and degree of tension of the chordæ vocales which they cover; and they can compress the sinus or sacculus laryngis. The thyro-arytenoid muscles are considered by some as the principal and most important agents in the production of voice, in consequence of their close connection to the vocal chords, and their capability of producing endless varieties in their condition, causing the vibration in their edges so to differ in intensity and duration as to produce from the air passing over them (to a certain extent only) corresponding varieties of sound or tone. These muscles are covered by the alæ of the thyroid cartilage and some intervening loose cellular tissue; they lie on the chordæ vocales, and on the intermediate sinus; superiorly their fibres extend to an indefinite height in the mucous folds of the glottis, and inferiorly they are connected to the following muscles.

Fig. 16.*

Crico-arytenoid Lateralis *arises* from the upper edge of the side of the cricoid cartilage, where the latter is covered by the ala of the thyroid cartilage, ascends obliquely backwards, and is *inserted* into the base of the arytenoid. *Use,* to draw that cartilage forwards and outwards, and thus to relax the vocal chords and enlarge the rima from side to side, but contract it from before backwards. These two last described muscles might be regarded as one, there being no very marked line of distinction between them. Raise the mucous membrane from the commencement of the œsophagus on the back part of the larynx, to expose the muscles situated there.

Fig. 17.†

Crico-arytenoid Posticus, strong and flat, *aris s* from the depression on the posterior surface of the cricoid; the fibres ascend obliquely outwards, *inserted* by a tendon into the outside of the base of the arytenoid cartilage. *Use,* to draw this cartilage backwards and outwards, so as to enlarge the rima in every direction, as in full inspiration. These muscles lie on the back of the cricoid cartilage, and are covered posteriorly by the pale mucous membrane descending into the œsophagus; these are the great dilators of the rima glottidis.

Arytenoideus fills the interval, and is inclosed in the fold of mucous membrane between the arytenoid cartilages; it consists of oblique and transverse fibres, the former are superficial, and consist of two or three fasciculi which pass from the apex of one cartilage to the base of the opposite; the transverse fibres are anterior to the former, more numerous, and are attached to the posterior surface of each cartilage. *Use,* to approximate these cartilages, and close the sides of the rima posteriorly; at the same time that they tend

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* A lateral view of the muscles of the larynx; the left ala of the thyroid cartilage having been removed. 1. The cut edge of the thyroid cartilage. 2. The divided edge of the crico-thyroid ligament. 3. The remaining ala of the thyroid cartilage. 4. Its ascending cornu. 5. The lateral surface of the cricoid cartilage. 6. 6. The arytenoid cartilages. 7. The first ring of the trachea. 8. The thyro-arytenoid muscle of the left side exposed by the removal of the left ala of the thyroid cartilage. 9. The crico-arytenoideus lateralis. 10. The left crico-arytenoideus posticus. 11. The arytenoid muscle.

† A posterior view of the larynx. 1. The posterior surface of the thyroid cartilage. 2. 2. Its ascending cornua. 3. Its posterior border. 4. One of its inferior cornua. 5. The posterior surface of the cricoid cartilage. 6. 6. The arytenoid cartilages. 7. 7. The crico-arytenoidei postici muscles. 8. The arytenoideus muscle. 9. The upper part of the trachea.

to separate their anterior processes, and thus can open the rima in front; these, together with the thyro and crico-arytenoid laterales, are the contractors of the rima glottidis. In the aryteno-epiglottidæan folds, fleshy fibres are sometimes discernible, and have been described as distinct muscles, and named, from their situation, aryteno-epiglottidæan, and thyro-epiglottidæan, or the depressors of the epiglottis.

In the human subject these are seldom sufficiently well marked to merit the appellation of distinct muscles. We shall, however, describe them as they are occasionally to be found.

Thyro-Epiglottici are situated between the thyroid cartilage and the epiglottis; *arising* from the internal surface of the angle of the thyroid, the fibres pass upwards and forwards to the base of the epiglottis, and are *inserted* into it, behind the thyro-epiglottidæan ligament; the action of these fibres will be to depress the epiglottis.

The Aryteno-Epiglottici *arise* from the apices of the arytenoid cartilages, and the membrane around them, pass forwards and upwards to the sides of the epiglottis, and the adjacent folds of mucous membrane; the action of these fibres must be nearly similar to that of the former.

Mr Hilton has described an inferior aryteno-epiglottidæan muscle, as arising from the arytenoid cartilage, just above the chordæ vocales, thence expanding forwards and upwards, over the sacculus laryngis, and inserted broad into the side of the epiglottis; its action he concludes to be, to compress and alter the form of this pouch, diminish its cavity, and compress the adjacent submucous glands.

The group of laryngeal muscles now described are exceedingly complex, and their actions, individually and collectively, by no means easily understood. The articulations between the thyroid and cricoid cartilages, and the arytenoid, allow of such varied and composite motions, and the rima glottidis is so differently affected by each, even by the slightest alteration in the chordæ vocales, that it is difficult, if not impossible, to appreciate the influence of each individual muscle; neither can we suppose that any such isolated action occurs during life, but, on the contrary, in every vocal exertion it is more than probable all these muscles are in a state of action, and by that harmonious consent and sympathy which is everywhere maintained in groups of muscles associated for one common purpose, they mutually adjust their states of action and of relaxation, in such nicely balanced proportions, as to produce the effect required, and that this exquisite degree of arrangement is acquired by an education and practice of the muscles, of which the will is scarcely cognizant; for although these muscles are, to a great extent, voluntary, and belong to the system of animal life, yet the will has not perfect control over their individual actions, neither can it separate those of one side from the opposite; nay, those fibres which are connected with the epiglottis, and which probably minister to the function of deglutition rather than to that of voice, appear wholly from under the influence of the will, and act in that spasmodic or convulsive motion, by which the food is hurried over the glottis and precipitated into the œsophagus.

The mucous membrane of the larynx is continued from that of the mouth, nose, and pharynx; it is soft, smooth, and of a delicate rose color, the tint differing in different situations; it incloses both the anterior and posterior surfaces of its back part, descends into it, covers every irregularity of the surface, lines every depression, and is continued through the trachea and bronchial tubes into the vesicular structure of the lungs, thus constituting the anterior division of the great internal or gastro-pulmonary mucous membrane. As this membrane passes from the tongue to the epiglottis, it forms three folds which serve to connect the latter to the former, of these three *glosso-epiglottic* folds the centre or frænum is the principal; is continued all round the free

surface of the epiglottis, and covers the entire of its posterior or laryngeal aspect; is reflected from its edges to the arytenoid cartilages, forming the aryteno-epiglottic poles or lateral boundaries of the opening of the glottis or larynx, these inclose some ligamentous fibres; as it descends it covers the chordæ vocales, lines the ventricles and sacculi laryngis, and the adjacent muscles, and finally becomes the lining coat of the trachea. It is perforated by numerous minute holes, the orifices of mucous ducts; the submucous tissue at the upper part is loose, and quickly admits of infiltration and swelling, or œdema, during inflammation, but below, as well as in the trachea, it is less in quantity, and of a more dense quality, therefore, inflammation is not succeeded so rapidly by submucous effusion, as it is by exudation of lymph upon its surface. Several mucous glands are connected with this membrane; the principal are to be found in the immediate vicinity of the ventricle and sacculus laryngis, and in the aryteno-epiglottidæan folds of mucous membrane; these latter are not to be confounded with the cuneiform cartilages which also occupy this situation, and were looked upon by some as glandular. The epiglottidæan gland or body, situated in front of the epiglottis, behind the os hyoides, and beneath the hyo-epiglottidæan ligament, has been already considered. Some describe, but most probably incorrectly, the porous appearance presented by the laryngeal surface of the epiglottis, as derived from the orifices of its ducts.

The *openings* of the larynx are two, the superior or the glottis, and the inferior or the tracheal. Intermediate, and nearly midway within the larynx, is a very remarkable slit-like narrowing of its cavity, named the rima of the glottis or larynx; this is occasionally, but certainly inaccurately, called the lower opening of the larynx, to distinguish it the more certainly from the upper extremity or the glottis; the rima, however, is by no means the lowest part of the organ; it is the narrowest portion of the air tube, and is the seat of the vocal function. The *superior opening* or the *glottis* is at the lower and anterior part of the pharynx, behind the epiglottis, and rather beneath the tongue; it is of a triangular form, the base anteriorly formed by the epiglottis; the sides are composed of the aryteno-epiglottidæan folds of mucous membrane, and the apex, which is posteriorly notched or bifid, is formed by the appendices of the arytenoid cartilages. The sides are somewhat thickened and strengthened by the inclosed cartilages or bodies; the aspect of this opening is upwards and backwards; when dilated it is the widest part of the tube; it is momentarily, but perfectly, closed during deglutition; its size and form, therefore, admit of every variety of change.

The *inferior opening* of the larynx is always free, and nearly a perfect circle, formed by the lower border of the cricoid cartilage, which is connected and continuous with the trachea: its size or figure cannot be altered by position or muscular action.

The *rima glottidis* is an horizontal, slit-like passage, about three-quarters of an inch below the glottis, bounded posteriorly by the mucous membrane connecting the bases of the arytenoid cartilages, and which covers a portion of the anterior surface of the arytenoid muscle, laterally by the chordæ vocales, chiefly the lower, and by the inner side of the bases of the arytenoid cartilages, and their anterior processes, and anteriorly by the angle of the thyroid. We might regard the rima as double, one placed horizontally above the other; the upper one, between the upper or false chordæ vocales, wide, and not so distinct as the lower or true rima, which is between the true vocal chords, and which is narrow, distinct, and sharp; the form of this true rima in a state of repose appears, on a superficial view, to be triangular, but on closer examination it will be found contracted behind the centre, and in fact may be described as consisting of three distinct parts, an anterior, middle, and posterior. The anterior is the space inclosed between the true chordæ vo-

cales, and extends from the angle of the thyroid to the anterior spurs of the arytenoids; the middle corresponds to the interval between the anterior thin edges of the arytenoid cartilages, and is the narrowest; the posterior is bounded by the internal sides of the bases of the arytenoid cartilages and the semilunar fold of mucous membrane, before alluded to as forming the posterior boundary of the rima; of these three spaces, the anterior is the most extensive, and of a compressed elliptical form; the antero-posterior diameter of this portion is often considerably increased by an excavation in the pomum Adami, or angle of the thyroid cartilage; this excavation is very remarkable in some of the larger ruminants. The middle division of the rima is the smallest, and the posterior is triangular, with an arched base, so that the three spaces, taken together, resemble the steel of a halbert in shape. The form of this opening, however, is variable, and depends on muscular action, as during every act of respiration, voice, or speech, it is subject to change in shape and size; thus in ordinary breathing it dilates during inspiration, and contracts in expiration. If the lateral crico-arytenoid muscles are alone thrown into forcible action, the arytenoid cartilages are rotated upon their articulations, so as to cause their anterior edges and spurs almost to meet, and thereby nearly divide the rima transversely into two unequal openings. The muscular action which appears most completely to dilate the rima, is the joint action of the crico-arytenoid laterales and postici, the former having the power of drawing the cartilages forwards and outwards, the latter backwards; the two forces will act in the diagonal, which is backwards and outwards, and so convert the rima into a lozenge-shape with unequal sides, the two anterior being longer than the posterior. The muscles which appear most completely to close the rima, are the arytenoid and thyro-arytenoid acting in conjunction; the former approximate the bases of the arytenoid, and the latter, causing the chordæ vocales to meet, at the same time prevent the anterior edges of the arytenoids being turned outwards, a motion which, we have seen, the unassisted action of the arytenoid accomplishes.

Immediately above the true chordæ vocales, the larynx presents, on each side, a lateral dilatation called the *ventricle* or sinus of the larynx; this elliptical space is bounded above by the semilunar folds, before alluded to under the name of the superior or false chordæ vocales; the mucous membrane lining these cavities presents numerous small glands, the mucus from which is constantly expressed by the action of the thyro-arytenoid muscle, which forms the outer boundary of this space. From each ventricle of the larynx the mucous membrane is prolonged upwards in a thimble-like form, constituting a pouch or *cul de sac*, first noticed by Morgagni, also described by Cruveilhier, and more recently by Mr. Hilton,* under the name of *sacculus laryngis;* it communicates with the ventricle by a narrow valve-like opening, extends upwards and forwards between the superior chordæ vocales and the ala of the thyroid cartilage to a variable distance in different individuals; in some these sacs are small, and even indistinct, whereas in others, they ascend as high as the upper border of the thyroid cartilage, and in front of the epiglottis, so that two probes, introduced into these cavities, can be carried so far forwards and inwards as almost to meet in front of the latter: this, however, is by no means a constant conformation. Each sac is lined by a thin membrane, and covered by the aryteno-epiglottic and thyro-epiglottic muscular fibres; many mucous glands open on its surface, the secretion of which serves to lubricate the chordæ vocales.

The arteries which supply the larynx are derived from the superior and inferior thyroid; the former is a branch of the external carotid, the latter of the subclavian; the accompanying veins open into the adjacent venous trunks.

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* Guy's Hosp. Reports, No. V.

As the surface of the larynx possesses exquisite sensibility, and its muscles execute delicate and complex actions, it requires a proportionably free supply of nerves. The laryngeal nerves are four in number, two on each side, the superior and inferior, or the recurrent nerves; both are derived from the par vagum or pneumo-gastric; the former arises near the base of the cranium; the latter, on the right side, arises in the lower part of the neck, and on the left in the thorax, below the arch of the aorta. The superior nerve first sends some filaments to the pharyngeal plexus, and to the lower part of the pharynx; next to the thyro-hyoid muscle, and to the thyroid gland; it enters the larynx either above the thyroid cartilage, or by a foramen in its ala, and then sends its principal branches to the mucous membrane around the epiglottis, also some to the arytenoid muscles, to the thyro-arytenoid, and crico-arytenoid lateralis; a long filament also to the crico-thyroid muscle, and descending filaments to anastomose with the recurrent. The inferior laryngeal nerve first gives off several cardiac branches, some to the trachea, œsophagus, and pharynx, and finally is lost in filaments which supply the crico-arytenoideus posticus, arytenoidei, crico-arytenoideus lateralis, and thyro-arytenoideus, and also anastomose with the superior nerve. The precise functions of each of these nerves it is difficult to ascertain; it is probable they are each compound nerves, that is, both motor and sensitive, but in inverse proportions; the superior partakes of the sensitive endowment much more than the inferior, which is eminently motor, as may be inferred from the distribution of its branches being almost wholly to the muscles, and which opinion has been confirmed by experiments. Sensibility is more exalted at the upper than at the lower part of the larynx, with the obvious design of affording protection to the air passages against the admission of any noxious gas or foreign substance; and here, accordingly, the mucous membrane is largely supplied by the sensitive portion of the superior laryngeal nerve, which, from its connections with the pharyngeal plexus, and thereby with the glosso-pharyngeal, pneumo-gastric, and sympathetic, will most intimately associate the apparatus for deglutition with this particular part of the larynx; while again the connection between the superior and inferior laryngeal nerves maintains that sympathy, which, between the several parts of so complex an apparatus, must be necessary to the due exercise of the functions of the whole.

An extensive range of sympathetic connections, interesting to regard in health, and important to reflect upon in disease, is maintained between the organ of voice, and the great vital functions of digestion, respiration. and circulation, through the medium of the laryngeal, cardiac, pulmonary, œsophageal, and gastric branches of the eighth pair, all of which are still further associated, not only with one another, but also with the great nervous centres, by their common and frequent communications with the great sympathetic or ganglionic system in the neck, in the chest, and in the abdomen. The reflex property of the nervous system is well exemplified in these nerves, as impressions made on the sensitive surface, and reflected to the medulla oblongata, are thence rapidly propagated to the motor nerves. The muscles of the larynx must be considered as belonging to the mixed class; in the production of the voice, with its various modifications, they are wholly under the influence of the will, and their actions are improved by age, by practice, and by education; but in deglutition, in spasmodic closure, and in the respiratory movements, the dilatation, and contractions of the glottis, corresponding to inspiration and expiration, and the design of which is to oppose the very contrary tendency in the current of air to and from the lungs, in all these, and in many other conditions, these muscles are wholly involuntary. (For a more particular description of these nerves, see *Par Vagum*, in *Nervous System*)

The larynx in the male is better developed than in the female; the angle of the thyroid cartilage, the base of the os hyoides, and the anterior segment

of the cricoid, are all much less prominent in the latter. In the infant it is proportionately small; the cartilages are weak, the chordæ vocales by no means strong and shining, the ventricles and laryngeal sacs scarcely visible, whereas the case of the os hyoides is large and prominent. The larynx undergoes but little change during the years of infancy and youth, and does not increase in the same ratio as other parts of the body; but at puberty, coeval with the changes in the reproductive organs, it is rapidly developed, so that in the course of a year it loses the infantine, and acquires the adult character, either male or female. Ossification commences at uncertain ages, seldom before thirty-five or forty years, but occasionally much earlier; it occurs first in the thyroid, next in the cricoid, and latest in the arytenoid cartilages, and is always more perfect in the male than in the female.

The larynx and trachea are subject to many *morbid* changes, of which the mucous membrane is most commonly the seat: inflammation of that lining the larynx is named cynanche laryngea, or laryngitis; of that lining the trachea, cynanche trachealis, or croup; in the latter case an exudation of lymph, or a false membrane, is usually formed in the trachea, in the former case, effusion of serum in the loose submucous tissue, or œdema of the glottis, is a frequent and often fatal effect; ulceration, the effect of inflammation, is not uncommon about the glottis, also diffuse inflammation ending in sloughing of the mucous and submucous tissues; syphilis and phthisis, too, occasionally induce ulceration in this part, and even involve the epiglottis and the arytenoid cartilages. All the cartilages, except the epiglottis, especially in men, are very prone to ossification; this can scarcely be regarded as disease; these bodies are also liable to inflammation, softening, ulceration, and change of form; the epiglottis is occasionally shrivelled and contracted, and even completely separated and discharged externally, or almost wholly absorbed, and yet deglutition may continue unimpaired. The articulations, particularly the crico-arytenoid, are subject to the same morbid changes as other synovial membranes; the muscles, without undergoing any obvious abnormal change in structure, are particularly liable to dangerous spasmodic affections, also to gout, rheumatism, and paralysis. Foreign bodies impacted in the lower part of the pharynx, or when engaged in the larynx, or when fallen into the trachea, may cause such suspension of respiration as to call for the operation of bronchotomy; suspended animation, also, from any cause, or any tumor in the fauces which impedes respiration, may require the same means; this operation is twofold, laryngotomy and tracheotomy; in the first the air tube is to be opened through the crico-thyroid ligament, in the second through the fourth, fifth, and sixth rings of the trachea.

SECTION VII.

DISSECTION OF THE DEEP MUSCLES OF THE NECK.

These muscles, which are seven in number on each side, form the third layer of the cervical muscles; they lie close to the vertebræ, and are exposed by removing the pharynx, larynx, cervical vessels, and nerves.

Longus Colli extends from the third dorsal vertebra to the atlas; it *arises* from the sides of the bodies of the three superior dorsal, and four inferior cervical vertebræ, from the intervetebral ligaments, also from the head of the first rib, and from the anterior tubercles of the transverse processes of the four last cervical vertebræ; the fibres ascend obliquely inwards, adhering to each bone in their course, and are *inserted* into the forepart of the first, second, and

third cervical vertebræ. *Use,* to bend the neck to one side, and rotate the atlas on the dentatus; or, if both muscles act, to strengthen and steady the neck, or to bend it directly forwards. This muscle appears to consist of an inferior and superior portion; the first, *arising* from the bodies of the dorsal, is *inserted* into those of the inferior cervical vertebræ; the second, *arising* from the transverse processes of the third, fourth, and fifth cervical vertebræ, is *inserted* into the bodies of the first and second. These muscles, like most of those which adhere to the vertebræ, though long, yet consist of short fibres which pass from one bone to another, are generally intermixed with tendinous substance, and are irregular as to the number of the vertebræ to which they are attached. The pharynx, œsophagus, sheath of the cervical vessels and nerves, are loosely connected to them in front.

Fig. 18.*

Rectus Capitis Anticus Major, long and flat, thick above and narrow below, *arises* by small tendons from the anterior tubercles of the transverse processes of the four last cervical vertebræ; they soon unite in a fleshy substance, which ascends obliquely inwards, and is *inserted* broad into the cuneiform process of the occipital bone. *Use,* to bend forwards the neck and head. This muscle lies behind the carotid artery and sympathetic nerve, and between the longus colli and scaleni, overlapping the former. Separate this muscle from its insertion, and we expose the following:

Rectus Capitis Anticus Minor, short and narrow, *arises* from the transverse process of the atlas, ascends inwards, and is *inserted* into the cuneiform process. *Use,* to bend the head forwards, and to one side, on the atlas; this muscle lies to the outer side, but is in part concealed by the last, and by the superior ganglion of the sympathetic, it lies on the atlanto-occipital articulation.

Rectus Capitis Lateralis, very short, *arises* from the transverse process

* The deep muscles of the neck. 1. A transverse section of the base of the skull. 2. The body of the seventh cervical vertebra. 3. The body of the first dorsal vertebra. 4. The longus colli muscle. 5. 5. The scalenus anticus muscle. 6. 6. The scalenus medius. 7. 7. The scalenus posticus. 8. The rectus capitis anticus major, drawn aside to show. 9. The rectus capitis anticus minor. 10. The rectus capitis lateralis. 11. The first cervical inter-transversalis.

of the atlas, ascends, and is *inserted* into the semilunar ridge or jugular process of the occipital bone, which extends from the condyle to the mastoid process. *Use*, with the last muscle it can bend the head forwards or incline it to one side. This muscle is external to that last described; it lies on the vertebral artery, and is covered by the jugular vein.

SCALENUS ANTICUS, at the root of the neck, in part continuous with the rectus anticus major, simple and broad below, but divided into slips above, *arises* tendinous from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; the fibres descend obliquely forwards and outwards, from a flat muscle, which is *inserted* tendinous into the upper surface of the first rib, near its cartilage. *Use*, to bend the neck forwards and laterally, also to elevate and fix the rib, as in inspiration. The phrenic nerve descends on the anterior surface of this muscle; the subclavian vein crosses its insertion; the transverse cervical vessels, the omo-hyoid and sterno-mastoid muscles, lie anterior to it; the subclavian artery and brachial plexus are behind it, and the vertebral vessels separate it from the longus colli.

SCALENUS MEDIUS, larger and longer than the last, *arises* from the posterior tubercles of the transverse processes of four or five inferior cervical vertebræ, by small tendinous fibres; these become fleshy, descend obliquely outwards and backwards, and are *inserted* into the upper surface of the first rib, behind the subclavian artery. *Use*, similar to the last. This muscle is covered by the brachial plexus, subclavian artery, and anterior scalenus.

SCALENUS POSTICUS *arises* from the posterior tubercles of two or three lower cervical vertebræ, descends behind the former, and is *inserted* into the upper edge of the second rib, between its tubercle and angle. *Use*, to elevate the second rib, to bend the neck to one side, and a little backwards. One or two branches of the brachial plexus sometimes separate this from the middle scalenus, at other times there is no distinction between them, excepting in their insertion; behind the posterior scalenus lie the transversalis and splenius colli, also the levator anguli scapulæ, which muscles cannot be examined at present. We shall next proceed to the dissection of the thorax.

CHAPTER III.

DISSECTION OF THE THORAX.

SECTION I.

OF THE MUSCLES ON THE ANTERIOR AND LATERAL PARTS OF THE THORAX.

THE thorax, or chest, is the middle division of the body, continuous with the neck above, and abdomen below; it contains the important organs of respiration and circulation, and serves as the basis of support and of attachment for the upper extremities; it presents an anterior or sternal, a posterior or dorsal, and two lateral or costal regions.

Make one incision through the integuments along the clavicle, a second from the upper end of the sternum to the ensiform cartilage, and from this point carry a third towards the shoulder; reflect the integuments and subjacent cellular membrane from within and from below, upwards and outwards,

and thus the great pectoral muscle will be exposed, the dissection of which will be greatly facilitated if its fibres be made tense by separating the arm from the side.* The integuments are thicker mesially than at either side, and more so in the male than in the female; in the former, also, they are more or less furnished with hairs. The superficial fascia is very variable, it adheres to the sternal and sterno-costal ligaments, but laterally is more loose and laminated; its deeper layer adheres to the pectoral muscle, continuous above with the superficial fascia of the neck, and below with that on the abdomen; near the epigastrium it is more dense, and binds down the recti muscles. The anterior region of the chest may be divided into three, the middle or proper sternal, and the two lateral or mammary regions; in the adult female these latter are of more importance, as they contain the mammary glands, which may now be examined.

The Mammæ, or Breasts, are conglomerate glands, sympathizing in a remarkable manner with the uterus, and designed to secrete the milk, that fluid which is to serve for some time as the nutriment for the infant. The importance of these organs is shown by the fact of a very large division of the animal kingdom being named, from their existence, "*Mammalia;*" this common character also implies, that all the females of this class are viviparous. In the human species, these glands are nearly symmetrical (the left is said to be very frequently larger than the right), and but two in number; in most other animals they are more numerous, generally in the ratio of two for each of the young they ordinarily bring forth, and are mostly placed on the abdomen; while in the human race they are situated on the chest, between the third and seventh ribs, so that the upper extremities can conveniently support the infant during lactation. The mammæ are also thoracic in the quadrumana and cheiroptera.

The integument of the breast is soft and smooth; in the young virgin of a pale white, or slightly bluish tint; but in the aged, or in those who have borne children, it becomes uneven, wrinkled, thicker, and darker: a little below the centre is the *nipple*, an organ which presents great variety of appearances, cylindrical or conical, very long, or short, and even so depressed that the infant's lips can with difficulty embrace it; it usually projects forwards and outwards, with a slight turn upwards; in the virgin it is a rounded cone and nearly smooth, but in the lactating woman it presents a flattened, cribriform surface, its extremity being the broadest part; in its centre are several depressions, or sometimes but one, in which are the small orifices of the milk ducts. It is surrounded by an areola, which in the young virgin is smooth and of a pale red, or pinkish tint, but in the pregnant female, or in one who has suckled, it acquires a dark brownish hue. A number of nervous papillæ and small tubercles, sebaceous follicles, stud the skin both of the nipple and the areola, the secretion from which defends it from excoriation during lactation, the nipple being at that period very tender and irritable, and liable to cracks or fissures. The nipple consists of a reddish, cellular, and sensible tissue, traversed by the lactiferous ducts; in the opinion of some this is erectile tissue, but on dissection it does not present the spongy, cavernous tissue of the true erectile, but rather a vascular, fibrous sort of dartoid structure, which may account for the occasional erection of this organ, and the sudden expulsion of fluid from its ducts: the nipple is securely connected to the gland by a fascia surrounding the ducts, derived from that of the breast.

* The student of some experience, instead of removing the skin from this region, according to the above directions, may rather practise the operation of extirpation of the breast, which can be easily accomplished by two semi-elliptical incisions, one below, and the other above the gland, through the integuments, and nearly parallel to the fibres of the great pectoral muscle, from which the gland can be then easily detached, unless disease should have caused any very close adhesion.

The mammary gland, when separated from the surrounding adipose substance, appears of an hemispherical form, convex in front, slightly concave behind, and separated by a thin fascia from the pectoral muscle, on which it can be freely moved; its circumference is thin and irregularly defined, some lobules being loose and scattered, and easily detached, particularly towards the axillary margin, hence it often presents an elliptical form in the transverse direction; its convex surface is uneven, deep cells, or alveoli, filled with adeps, which previously smoothed off these irregularities; there is less of this adipose matter around the nipple than more externally. The gland is surrounded by a capsule of cellular membrane, very variable in strength and distinctness; it is prolonged into the gland, and separates and connects its lobules, vessels, and nerves; these processes (ligamenta suspensoria) are analogous to the septa in the testis; anteriorly they are connected to the skin, and posteriorly to the fascia of the great pectoral: thus they also serve to suspend and maintain the organ in its position; in the old or emaciated, these become weak and elongated, and the breast no longer occupies its original seat. This tissue in some is dense and fibrous, in others loose and cellular; on those differences depend, in a great degree, the firmness or softness of the organ; the interstices between these septa are filled with adeps, on the greater or lesser quantity of which the size of the organ in a great degree depends; owing to the same cause also the breasts in the male are occasionally found of considerable magnitude.

The interior of the gland presents a white, fibrous appearance, divisible into masses, without that granular arrangement common to other conglomerate glands; during lactation, however (the most suitable condition for the examination of the organ), the glandular grains are distinct, though very minute; these granules are united into flattened globules, and these again into lobes; from each group of lobules a small excretory duct issues, evident by its white color; this, if injected, can be traced back into fine divisions, each of which ends, or rather commences in the fine cœcal vesicle of which each granule is composed; these ducts converge towards the areola, increasing in size but diminishing in number; near the base of the nipple these terminate by five or six branches in small ampullæ, or reservoirs; in the human subject these scarcely deserve the name, but in most other mammalia they are of considerable size; in the cow, for example, they can contain a quart of fluid. From these ampullæ the straight tubes proceed, twelve to twenty in number, and open on the cribriform surface of the nipple by very small orifices; each duct is lined by an inflexion of the skin, which then assumes the mucous character, and is covered by a fine cellulo-fibrous tissue. Injection demonstrates, that the milk ducts have no valves, also that there is but little communication between them, or between the different lobes, as these latter can be injected with different colored fluids; hence, the breast may be regarded as an aggregate of glands, each capable of independent action, and each also liable to isolated disease.

The mammary gland derives its arteries from the thoracic branches of the axillary, from the intercostals, and from the internal mammary, which inosculates with the epigastric. The veins preponderate, and are arranged in two orders; the deep set accompany and are closely connected to the arteries; the superficial are subcutaneous, and well developed, especially around the areola, where they present a plexiform anastomosis, thence they pass towards the circumference of the organ to join the deeper veins; they can often be distinctly seen during life, and are very frequently much developed, and even varicose in certain morbid conditions of the organ, also in elderly persons, or where the organ, once large, has become atrophied.

The nerves of the gland are derived from the intercostals, and from the

brachial plexus, while the integuments receive some filaments from the cervical nerves.

The absorbents are very numerous; they are superficial and deep; the first proceed from the nipple and cutaneous glands; the second from the glandular structure; these pass into the axilla, enter the absorbent glands, and then ascend, some internal, others external to the axillary vessels; some open into the angle between the jugular and subclavian veins, others join the absorbents of the arm. From the sternal side of the nipple absorbent vessels also proceed, these pass through the intercostal spaces, into the mediastinum, and some absorbent glands situated there; some of these on the right side communicate with the absorbents of the liver; all these vessels finally end in the angles between the jugular and subclavian veins. Some absorbents also pass from the posterior surface of the gland through the pectoral and intercostal muscles, accompany the intercostal vessels round to the posterior mediastinum, and either enter into the absorbent glands in that region, or at once join the thoracic duct. In the breasts these different sets of absorbents communicate together.

The mammary glands in the male deserve examination, and require some brief description. The size is very variable, in some not larger than a pea, in others they equal two inches. In those of effeminate appearance, or in whom the testes are atrophied, these glands have been found of the greatest size. The nipple and the areola present papillæ and tubercles, as in the female, but smaller and less vascular. The gland consists of minute cells, and numerous small conical ducts, branching through it; these end in straight tubes which open on the nipple, and the whole is supported by a fascia. Cases are on record of the breasts in the male being found as large as in the female, and of the ducts emitting a serous fluid with the appearance of milk; such cases explain the possibility of the male parent sustaining the infant, of which some well-authenticated instances are recorded.

The female breast is the seat of many morbid changes, viz., inflammation and suppuration, either in the body of the gland, or in the cellular tissue around it or behind it, that is, between it and the muscle; enlargement; atrophy; tumors of various kinds, adipose, hydatid, cartilaginous, scirrhous, cancerous, &c.; some indolent, chronic, and innocuous, others more rapid in their progress, fungoid, and malignant; some involving the entire organ, others confined to certain lobes, or certain portions of the interlobular cellular tissue.*

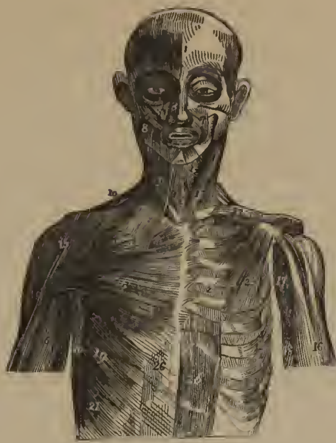
TABLE OF MUSCLES.

"Pectoralis Major,	*Vide page* 80.
Pectoralis Minor,	" 82.
Subclavius,	" 82.
Serratus Magnus Anticus,	" 82.
Intercostales Externi—*eleven pairs,*	" 84.
Intercostales Interni—*eleven pairs,*	" 84.
Levatores Costarum—*twelve pairs,*	" 84.
Triangularis Sterni—within the Thorax."	" 84.

Pectoralis Major, flat and triangular, *arises* somewhat tendinous from the sternal half of the clavicle, from the anterior surface of the sternum, fleshy from the cartilages of the third, fourth, fifth, and sixth true ribs, and from an aponeurosis common to it and the external oblique muscle; the clavicular fibres descend, the sternal pass horizontally, and the costal ascend obliquely; all pass outwards in front of the axilla towards the humerus, into

* See the invaluable treatise on this organ by Sir A. Cooper.

Fig. 19.*



which they are *inserted* by a flat tendon into the anterior edge of the bicipital groove, and by an aponeurosis into the fascia of the arm; a line of cellular membrane separates the clavicular from the sternal portion; in some cases these appear as distinct muscles. *Use*, the clavicular portion can raise the arm and draw it forward, the sternal can press it to the side, particularly if assisted by the latissimus dorsi, and the costal portion can draw it downwards and forwards: the whole muscle will draw the arm forwards and inwards on the chest; if the arm have been rotated outwards it can roll it inwards, and so pronate the hand; if the arms be fixed, and this pair of muscles act, they will draw the ribs upwards and outwards, and thus, by enlarging the thorax, assist in inspiration. This muscle is covered by the skin, platysma, and mammary gland, and its insertion is partly concealed by the deltoid; it covers a portion of the sternum and of the true ribs, also the subclavian and lesser pectoral muscles, the coraco-clavicular ligament, the thoracic and axillary vessels and nerves. Between the clavicular portion of this muscle, and the anterior edge of the deltoid, is a space filled by cellular tissue, the cephalic vein, and a small artery. The tendinous fibres of the sternal portions of opposite sides decussate each other, and cover the sternum with a sort of aponeurosis; the insertion has a twisted appearance in front of the axilla, the sternal and costal portions being folded behind the clavicular, and *inserted* superior and posterior to it into the interior edge of the bicipital groove, while the clavicular is united to the deltoid, and is *inserted* into the humerus along with that muscle; in some subjects a bursa may be found between these two insertions of the pectoral muscle. From the lower edge of the costal portion a fleshy slip sometimes descends and joins either the rectus or

* The muscles of the anterior aspect of the trunk; on the right side the superficial layer is seen, and on the left side the deeper layer. 1. The frontal portion of the occipito-frontalis muscle. 2. The orbicularis palpebrarum. 3. The levator labii superioris alæque nasi. 4. The levator labii superioris proprius. 5. The zygomaticus minor. 6. The zygomaticus major. 7. The levator anguli oris. 8. The masseter. 9. The platysma myoides. 10. A portion of the trapezius. 11. The sterno-hyoid and thyroid muscles. 12. The upper portion of the omo-hyoid muscle. 13. The sterno cleido-mastoideus. 14. The pectoralis major. 15. The deltoid. 16. The biceps. 17. The coraco-brachialis. 18. The triceps. 19. The serratus magnus. 20. A portion of the latissimus dorsi. 21. A part of the obliquus externus abdominis. 22. The pectoralis minor. 23. The subclavius muscle. 24. One of the internal intercostal muscles. 25. One of the external intercostals. 26. The rectus abdominis; on the left side the sheath of the muscle has been removed.

external oblique muscle of the abdomen; and in some a strong muscular band connects it to the inferior margin of the latissimus dorsi; a tendinous band also has been observed to ascend from the upper edge of its insertion to the capsule of the joint. Make a perpendicular division of this muscle, reflect the edges, one towards the sternum, the other towards the shoulder; and the lesser pectoral and subclavian muscles come into view.

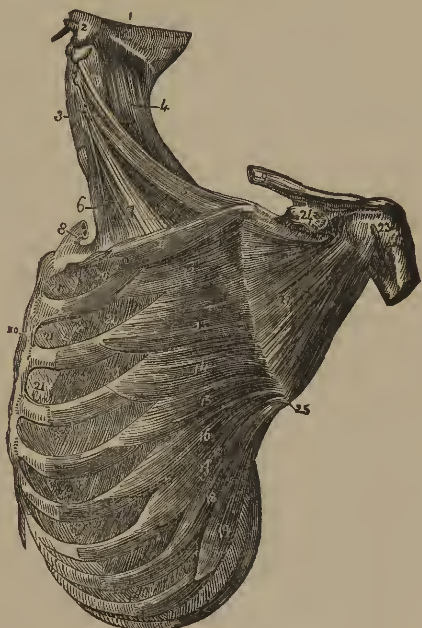
Pectoralis Minor, flat and triangular, *arises* from the external surface and upper edge of the third, fourth, and fifth ribs, sometimes from the second, external to their cartilages; the fibres ascend obliquely outwards and backwards, and converging, end in a flat tendon, which is *inserted* into the inner and upper surface of the coracoid process, near its anterior extremity, being here connected with the coraco-brachialis and short-head of the biceps; a band of this tendon frequently passes over this process through the triangular ligament, and is connected to it, or to the tendon of the supra-spinatus, or to the capsular ligament of the shoulder. *Use*, to draw the shoulder forwards, downwards, and inwards, also to assist the great pectoral in elevating the ribs in inspiration. This muscle is covered by the great pectoral, by the superior thoracic vessels and nerves, and partly at its insertion by the margin of the deltoid muscle, a few of its inferior fibres are covered only by the skin; it lies anterior to the serratus magnus, axillary vessels, and nerves. As this muscle does not ascend so high as the clavicle, it forms the inferior boundary of a small subclavicular triangular region, which is bounded above by the subclavian muscle and costo-coracoid aponeurosis, or ligament; internally by the ribs, and externally by the coracoid process: this space is traversed by the axillary vessels and brachial plexus of nerves; it is closed, or covered by the clavicular portion of the great pectoral; the cellular fissure between which and the deltoid leads into it; by expanding this, or by dividing a portion of the great pectoral, this space can be opened sufficiently to expose the axillary artery for the purpose of tying it.

Subclavius, small and round, *arises* by a flat tendon from the cartilage of the first rib, external to the rhomboid, or costo-clavicular ligament, soon becomes fleshy, and ascending outwards and backwards, is *inserted* into the external half of the inferior surface of the clavicle, extending as far outwards as the space between the conoid and trapezoid ligaments. *Use*, to draw the clavicle and shoulder forwards and downwards, also to elevate the first rib in inspiration, if the shoulder and clavicle be raised and fixed. This muscle is covered by the clavicle and great pectoral; it lies anterior to the axillary vessels and nerves, which separate it from the first rib; it is inclosed inferiorly in a thin but strong aponeurosis, which is attached to the cartilage of the rib, to the clavicle and subclavian muscle, from which it passes downwards and outwards to the coracoid process, arching across the great vessels, is then connected to that process, and to the tendon of the lesser pectoral; this fascia is called by some the *coraco-clavicular ligament*, by others, the *costo-coracoid;* it is sometimes very strong, and from the manner in which it is tensely extended over the vessels, and continued along them, especially the vein, it renders it difficult to feel the pulsation of the axillary artery below the clavicle, as also to separate it from the vein and nerves between which it lies.

Serratus Magnus, thin and broad, particularly anteriorly, placed behind the pectoral muscles and the axillary vessels, and between the scapula and the ribs, *arises* by eight or nine fleshy slips, from the eight or nine superior ribs; the fibres ascend obliquely backwards, and are *inserted* between the subscapular, the rhomboid, and levator anguli muscles into the base of the scapula, but particularly into the superior and inferior angles. *Use*, to depress the scapula and draw it forwards, particularly the inferior angle, and thus by rotating this bone on its axis, to raise the acromion process and the shoulder joint; when the upper extremity is fixed, this muscle can raise and draw out-

wards the ribs, so as to assist very considerably in inspiration. The serratus mangus lies on the ribs and intercostal muscles; also on a portion of the serratus posticus; external to it are the axillary vessels, the scapula and subscapular muscle; the trapezius, latissimus dorsi, and rhomboid muscles lie behind it, and the pectoral muscles are anterior to it; an abundance of loose cellular membrane connected to its surfaces allows it to glide on the ribs, and also facilitates the movements of the scapula upon it. The four superior digitations lie behind those of the lesser pectoral, and the four inferior, which are only covered by the skin, indigitate with the origins of the external oblique. If the clavicle be separated from the sternum, and the scapula pulled from the side, this muscle will then become tense, and in this state it appears to consist of three portions, which differ in structure and in form: the *superior* is a thick, short, and strong fasciculus, somewhat square, passing from the two first ribs beneath the axillary vessels and brachial plexus, to the superior angle of the scapula; its flat surface is directed upwards, and lies on a plane anterior to the next or *middle division*, which is very thin, consisting of but

Fig. 20.*



few fleshy fibres, connected together by an aponeurosis. This portion is of a triangular form, the apex attached to the third and fourth ribs, the base to

* A lateral view of the thorax and neck. 1. A portion of the occipital bone. 2. The mastoid process of the temporal bone. 3. The anterior surface of the bodies of the cervical vertebræ. 4. The deep layer of muscles of the posterior cervical region. 5. The levator anguli scapulæ. 6. The anterior scalenus muscle. 7. The middle and posterior scaleni. 8. The internal portion of the clavicle which has been sawn across. 9. Its external portion. 10. The sternum. 11. 12. 13. 14. 15. 16. 17. 18. 19. The costal attachments of the serratus magnus. 20. 20. 20. The external intercostal muscles. 21. 21. 21. Portion of the internal intercostals. 22. The subscapular muscle. 23. The head of the humerus. 24. The coracoid process of the scapula. 25. The inferior angle of the scapula.

the basis of the scapula, not always to the bone, but sometimes to a strong tendinous cord, or arch, which extends along this line from the superior to the inferior angle, and which is also common to the insertion of the greater rhomboid; in some two such tendinous arches exist, and in others none. The third, or *inferior* division of the serratus is the strongest and most extensive; it is radiated or triangular; the apex thick and fleshy, attached to the inferior angle of the scapula; the base expanded in thin and long fasciculi on the ribs: to this portion the external respiratory nerve is chiefly distributed. The serratus may be again examined when dissecting the muscles on the back of the trunk.

Intercostales are twenty-two in number on each side, eleven external and eleven internal; the *external* commence at the transverse processes of the dorsal vertebræ, *arise* from the inferior edge of each rib, descend in fasciculi obliquely forwards, and are *inserted* into the external lip of the superior edge of the rib beneath, and terminate a little behind the costal extremity of the cartilages; an aponeurosis, the fibres of which run in the same direction, supply their place as far as the sternum. The *internal intercostal muscles* take an opposite direction, and decussate the former; they commence at the sternum, and are discontinued at the angles of the ribs; they *arise* from the inner lip of the lower edge of each cartilage and rib; the fibres, paler and shorter than those of the external, descend obliquely backwards, and are *inserted* into the inner lip of the superior edge of the cartilage and rib beneath. *Use*, both laminæ co-operate to raise the ribs, the first rib being fixed by the scaleni. The intercostal muscles, in elevating the ribs, also evert their lower edges, and twist them at their vertebral and sternal ends, and thus assist in inspiration by enlarging the chest transversely, and from before backwards. The internal layer lies on the pleura, and is separated from the external by the intercostal vessels and nerves; the external layer is connected to the pleura only in the space between the angles of the ribs and the vertebræ. At the posterior extremity of the external intercostal muscles, there are the following twelve small muscles, which, however, may be seen more fully when the muscles of the back have been dissected.

Levatores Costarum *arise* narrow and tendinous from the extremity of each dorsal transverse process, descend obliquely outwards, and are *inserted* broad into the upper edge of the rib beneath, between its tubercle and angle; their name denotes their *use*. They are parallel to, and frequently appear as a portion of the external intercostals; the first levator is short, and arises from the last cervical vertebra; the inferior increase in length and size. These muscles are arranged by some, and not improperly, among those of the back. Behind the sternum are a pair of small muscles, which cannot be seen until this bone is removed; we describe them now, although their dissection may be postponed until the thorax has been opened.

Triangularis Sterni, or sterno-costalis, *arises* from the posterior surface and edge of the lower part of the sternum, and from the xiphoid cartilage; the fibres ascend obliquely outwards, the inferior pass transversely, *inserted* into the cartilages of the fourth, fifth, and sixth ribs. *Use*, to depress and draw backwards the cartilages of the ribs, so as to assist in expiration. These muscles lie on the pleura, pericardium, and diaphragm, are covered by the sternum, cartilages of the ribs, and mammary vessels. They antagonize the external intercostals, to whose fibres, however, they are parallel, but they arise from the more fixed, and are inserted into the more movable part of the cartilage, and this fact also explains the cause of the external intercostals terminating at the ends of the ribs, and not continuing as far forwards as the sternum. The mechanism of respiration shall be further considered when the diaphragm has been examined (see dissection of it). In connection with the muscles of the thorax, the student should study the anatomy of the axilla.

SECTION II.

DISSECTION OF THE AXILLA.

THE *Axilla* is a conical, or rather a triangular, pyramidal-shaped cavity, the apex superiorly at the coracoid process and clavicle, the base below, between the pectoralis major, and the latissimus dorsi muscles, and formed by the skin and a thick fascia; it is bounded anteriorly by the great and lesser pectoral muscles, internally by the serratus magnus and the ribs, externally by the scapula, subscapular muscle, and the upper part of the humerus, and posteriorly by the serratus, latissimus dorsi, and teres major muscles. The internal and posterior walls unite in an acute angle along the base of the scapula; this angle is completely closed by the serratus muscle; the anterior and internal, or thoracic boundaries also unite in a very acute angle, which is prolonged upon the thorax, beneath the pectoral muscles; the external angle is truncated, and presents a somewhat round surface, formed by the coraco-brachialis muscle, the humerus, and the shoulder joint; the axillary artery can be compressed against the lower part of this surface. The axilla contains several lymphatic glands, vessels, and nerves, and a quantity of loose cellular and adipose tissue, which is continued from the neck beneath the clavicle, and which often presents a watery reddish appearance. When the pectoral muscles have been divided, and some cellular membrane removed, the *axillary vein* first appears; at the upper part of the axilla, this vessel is very large, and is internal and anterior to the artery, connected to it by compact cellular tissue; it here rests upon the first intercostal muscle, the second rib, and the upper part of the serratus magnus; the coraco-clavicular aponeurosis adheres to, and is continued on its anterior surface, it is also crossed by the thoracic arteries and nerves; through the rest of the axilla it approximates the artery, and descends more directly in front of it, though inclined to its inner side, and separated from it by the anterior branches of the brachial plexus of nerves; it receives the basilic vein below, the cephalic above, and the subscapular, circumflex, and thoracic branches intermediate.

The *axillary artery* may be next seen, taking an oblique course downwards and outwards through this space, larger above, and close to the thorax, smaller below, and nearer to the arm; thoracic and acromial branches are derived from it in front, the circumflex and subscapular behind; all these branches, and even the trunk itself, are liable to varieties in size, number, position, and distribution. (See *Vascular System*). At the upper part of the axilla, the *brachial plexus of nerves* is seen behind, and to the outer side of the artery, its cords collected into a bundle; posterior to the lesser pectoral muscle it is somewhat unravelled, and its branches are entangled around the artery; it then divides into axillary and brachial nerves, the former are the anterior and posterior thoracic and subscapular, the latter are the internal, cutaneous, median, ulnar, external or musculo-cutaneous, musculo-spiral, and articular or circumflex. Two or three filaments from the superior intercostal nerves traverse this region transversely, in front of the serratus, and are entangled with the thoracic vessels and nerves. Descending on the forepart of the serratus magnus, behind the great vessels and nerves, is the external respiratory nerve, a branch derived from the first roots of the plexus in the supra clavicular region. At the lower part of the axilla, the artery may be observe din general to lie between the two roots of the median nerve, with the external cutaneous to its outer or humeral side, and with the ulnar and internal cutaneous to its inner or thoracic side, while posterior to it are the musculo-spiral and articular nerves. The general distribution of these branches will be no-

ticed in the dissection of the upper extremity, and for their particular description see *Anatomy of the Nervous System.*

The lymphatic vessels in this region are numerous and distinct, the principal set ascend from the arm; these are joined by several from the exterior of the thorax, from the mammary region, and from the inferior posterior part of the neck. The lymphatic glands are connected to the axillary vessels by the small branches which supply them; one series of these lies posterior to the edge of the pectoral muscle; from this a chain continues up to the coracoid process, and beneath the clavicle to the glands in the neck; another series lies on the subscapular muscle, and several are scattered indifferently through the axilla. In cases of malignant affections of the breast, some of these glands are often found diseased and require to be removed by the surgeon, at the time of extirpating the former. These glands also, together with the surrounding cellular membrane, are very subject to acute inflammation and suppuration; large collections of pus are the result, which, if not opened sufficiently early, may prove troublesome, and even dangerous; by pressure on the nerves and lymphatics, œdema and debility of the arm are induced, or the fluid may burrow between or beneath the muscles, and, by compressing the chest, distress the respiration, or it may even open through one of the intercostal spaces into the cavity of the pleura.

SECTION III.

DISSECTION OF THE CAVITY OF THE THORAX.

The thorax is situated at the upper and anterior part of the trunk; it contains the lungs, the organs of respiration; the heart, the chief agent in the circulation of the blood, also several nerves and vessels passing to and from the heart, and through the cavity. This region is bounded anteriorly by the sternum and costal cartilages, laterally by the ribs and intercostal muscles, posteriorly by the vertebræ and angles of the ribs, inferiorly by the diaphragm, superiorly by the several muscles and fasciæ connected to the clavicle, first rib, and sternum, and by the different parts passing into and out of the cavity. The thorax, viewed externally, presents a very different form before and after the upper extremities have been detached from it; in the former state it appears of great transverse width above, and narrow below; whereas in the latter condition, it is seen to be very contracted above, and expanded below. The thorax may be compared to a section of a cone, the posterior fourth being removed, the three anterior parts retained and united to each other. The axis of the cavity is oblique from above, downwards, and forwards; the base of the thorax is also oblique from before, backwards, and downwards, and the apex on the contrary is oblique from behind, forwards, and downwards; hence the perpendicular diameter of the thorax is much greater posteriorly than it is behind the sternum. The apex of the thorax is somewhat truncated, and presents an oval opening, longer transversely than from before backwards; this, the *superior orifice of the thorax,* is bounded anteriorly by the upper edge of the sternum and interclavicular ligament, posteriorly by the last cervical and first dorsal vertebræ, and laterally by the first ribs; the several important parts which pass through this opening shall be noticed afterwards. The inferior circumference of the thorax is five or six times more extensive than the superior; it is bounded by the xiphoid, the last true and all the false costal cartilages, and by the last dorsal and first lumbar vertebræ; its longer diameter is also transverse. Open the cavity by dividing

Fig. 21.*

the cartilages of the ribs on each side of the sternum, and raising the latter from below upwards; if we look under the sternum as we thus slowly raise it, we perceive that space called *anterior mediastinum* to be gradually developed, from the right and left pleuræ, separating from each other as we tear the loose cellular membrane, which naturally connects these membranes and the pericardium to the posterior surface of the bone; when the sternum is removed, this region is fully exposed; it is described as being of a triangular form, the base, the sternum; the sides, the pleuræ, converging behind, so as nearly to touch each other; the apex, the small portion of pericardium left uncovered by the pleuræ; naturally, however, all the parts within the thorax are so closely applied to the parietes, that no space or cavity of a defined form, like that assigned to the anterior mediastinum, can truly be said to exist.† The dissector, however, may cause this space to ap-

* The situation and relations of the lungs, the heart, and the great vessels in the thorax. 1. 1. The pericardium cut open and its anterior portion removed, in order to display the heart. 2. The superior vena cava. 3. The same vessel covered by the pericardium, descending to 4. The right auricle of the heart. 5. The right or pulmonic ventricle of the heart. 6. The pulmonary artery arising from the right ventricle. 7. The appendix of the left auricle. 8. The left or aortic ventricle of the heart. 9. The ascending portion of the arch of the aorta. 10. The transverse portion. 11. The arteria innominata. 12. The left carotid. 13. The left subclavian. 14. 14. The thyroid body or gland. 15. The trachea. 16. 16. The lungs. 17. 17. The pleuræ.

† For the purpose of examining the morbid appearances after death, the cavities of the thorax and abdomen are generally opened at the same time; an incision, carried from the top of the sternum to the symphisis pubis, through the teguments, muscles, and peritoneum, will bring the latter cavity into view; next let the skin and muscles covering the front of the thorax be turned back, which will expose the cartilages connecting the ribs with the sternum; immediately at their point of connection with the bone, these are to be cut; in doing this take care not to wound the viscera within.

In some old subjects, where the cartilages of the ribs are in some degree ossified, a saw

pear more distinct by the following precaution: before you divide the cartilages, push your fingers from the abdomen behind the sternum, and break down the cellular connections between it and the pleuræ, then cut the cartilages very near the sternum, and raise the latter; without this precaution before dividing the cartilages, the pleuræ, particularly the right, will be in almost every instance laid open, and so the appearance of the anterior mediastinum injured. This region in general inclines a little to the left side below, in consequence of the left pleura being more attached to the pericardium, which lies rather to the left of the middle line, whereas the right pleura is connected to the sternum in a vertical line; the anterior mediastinum is wider superiorly and inferiorly than in the centre, hence, some compare it to the letter X, and describe it as consisting of two triangular spaces, their apices joined in the centre, the base of one towards the neck, and that of the other towards the diaphragm; the superior portion is larger in the fœtus, contains the origins of the sterno-hyoid and thyroid muscles, and the remains of the thymous gland; inferiorly there is much loose cellular membrane, which leads from the neck to the abdominal muscles, also lymphatic glands, and close to the sternum are the mammary vessels, and the triangularis sterni muscle of the left side. Next examine the organs on each side of the thorax; these are the lungs and their investing membranes the pleuræ; in almost all respects these organs are similar on the right and left side, and therefore either may be selected for examination; for this purpose lay open one side, suppose the right, of the thorax, by sawing through the ribs about their centre, and removing their anterior portion; the first rib may be left uninjured; thus the cavity of the right pleura will be opened, its glistening surface seen, with the lung lying collapsed; or, having divided with the saw six or seven ribs at their angles, and cut through their cartilages near the sternum, the intervening bones may be raised by a careful dissection from the pleura, without opening the cavity of the latter.

The *pleuræ* are serous membranes, their internal surface is smooth, polished, and free; their external surface is connected by fine cellular membrane to the parietes of the thorax, and to the tissue of the lungs, over which they are reflected. That portion of each which invests the lungs is called *pleura pulmonalis,* and that which is connected to the parietes *pleura parietalis* or *costalis,* the latter portion of the membrane is much more dense and strong than the former; each pleura is a shut sac, of a conical shape, and contains only the serous vapor it exhales; for although the lung appears within the cavity, it is yet really external to it or behind it; internally each pleura presents one continuous surface, which can be traced throughout its whole extent; thus we can perceive that the right pleura passes from the back of the sternum to form the side of the anterior mediastinum, and, arriving at the forepart of the pericardium is continued along the side of that bag as far back as the root of the lung, whence it is reflected over the anterior surface of this organ, sinking into its fissures, and connecting all its lobules to each other; having thus invested the whole lung, it arrives at the posterior surface of its root, from which it is reflected to the back part of the pericardium, where it approaches the opposite pleura, to which it is connected by cellular membrane; thence it passes to the sides of the vertebræ, thus forming the side of the posterior mediastinum, (to be examined presently;) the pleura then expands along the side of the spine, ascending as high as the transverse process of the sixth or seventh cervical vertebra, and descending to the dia-

must be employed; all the cartilages, except those of the first rib. being divided, the sternum may be raised like the lid of a box, and a very convenient hinge is made by cutting the articulation between the first and second pieces of the sternum on the inside, opposite the second rib; the figure of the thorax will thus be preserved, and a sufficient view be obtained of its contents.

Fig. 22.*

phragm, the convex surface of which it covers; on this muscle also it is reflected from the lower edge of the root of the lung by a fold called *ligamentum latum pulmonis,* loose and triangular, the base towards the diaphragm, one side connected to the lung, and the opposite to the mediastinum; from the vertebræ the pleura continues to pass outwards, lining the ribs and intercostal muscles, as far forwards as the side of the sternum, where the sac was opened, and the description commenced. The pleuræ are of a conical form, the apex of each is in the neck, covered by the anterior scalenus and subclavian artery; the base adheres to the diaphragm; the right pleura is shorter but broader than the left, which is long and narrow; the liver on the right side and the heart on the left cause these differences to exist; the apex of the right is often higher in the neck than that of the left. The pleura is covered by a strong fascia, which can be detached more easily from the costal than from the other divisions of this membrane, except the confines of the mediastina; the phrenic portion is more adherent than the costal, but

* A transverse section of the thorax opposite the fifth dorsal vertebra, to show the relation of the pleura to the walls of the chest, to the lungs, and to the pericardium. 1. The body of the fifth dorsal vertebra. 2. 2. Sections of the ribs. 3. A section of the sternum. 4. A section of the right lung. 5. Of the left lung. 6. The anterior surface of the heart, covered by the serous layer of the pericardium. 7. The trunk of the pulmonary artery issuing from the right ventricle of the heart. 8. The left, and 9. The right branch of the pulmonary artery. 10. A section of the aorta immediately above the sigmoid valves. 11. A part of the left, and 12. Part of the right auricle. 13. The superior vena cava. 14. The left bronchus. 15. The right bronchus. 16. The œsophagus. 17. The thoracic aorta. 18. 18. The cavity of the pleura. 19. 19. The costal layer of the pleura. 20. 20. The pleuræ passing from the posterior walls of the chest, over the sides of the vertebral column to the posterior surface of the root of the lungs, leaving between them the interval, 21. 21. called the posterior mediastinum. 22. The pulmonary layer of the pleura, covering the outer surface of the lung, and sinking into its fissures. 23. 23. The same membrane covering the internal surface of the lung. 24. 24. The pleura, passing from the internal surface of the lungs, over the anterior surface of their roots, to attach itself to the sides of the pericardium. 25. 25. The pleura leaving the pericardium to reach the posterior surface of the anterior wall of thorax, where it is continuous with 19. The costal layer. 26. The anterior mediastinum.

less so than the pulmonic; on the pericardiac, and sometimes on the phrenic portions, small, fatty appendices exist, analogous to those on the colon intestine. All portions of the pleuræ are covered by a fascia, which in some situations is so fine, delicate, and transparent, as to be difficult of demonstration; on the costal portion it is very strong, on the phrenic less so, on the mediastinal it is very distinct, and even appears in some places continuous with the fibrous layer of the pericardium, though separated from it in others, as in the line of the phrenic nerves; beneath the pulmonic, in a perfectly healthy lung, it is extremely thin, though strong, resisting, and elastic, and can be exposed by very cautiously scratching off the serous layer from a small portion of lung distended and held tense; the transparent fascia can then also be dissected off the air cells; therefore, strictly speaking, the pleuræ are, like most other serous and synovial membranes, fibro-serous, and consist of three layers or tissues; the external or the adherent layer is fibrous, the middle a fine, subserous, cellular tissue, and lastly, the serous lining. In the costal, phrenic, and mediastinal portions, these three components can at all times be made distinct, and equally so in the pulmonic portion on a lung which has been long affected with chronic inflammation. This fibrous structure of the pleura serves to explain the pain of pleurodyne and pleuritis, also, as Cruveilhier remarks,* why external abscesses so seldom perforate into the cavity of the chest, and why pleuritic effusions are so long retained before they point externally; also, as Stokes† has observed, the rarity of perforations of the pleura pulmonalis in ulcerations of the lung, which have approached so near the surface as to be bounded only by this fibro-serous investment. The *uses* of the pleuræ are to serve as a fine, yielding, elastic, and insulating integument to the lungs, to strengthen the diaphragm, and to complete the walls of the thorax, while the lubricating serous exhalation which constantly moistens the polished, and at all times contiguous surfaces of their visceral and parietal layers, facilitates those mechanical changes in the form of the lungs, and in the condition of the walls of the chest, which are requisite in the respiratory process. The two pleuræ have been resembled to two bladders placed nearly parallel to each other, not having any communication, but touching each other along the mesial line; this juxta-position of the two pleuræ between the sternum and vertebræ forms a sort of partition between the right and left side of the thorax; this partition is called mediastinum; it consists, of course, of two laminæ, right and left, connected anteriorly to the sternum, posteriorly to the spine; these laminæ are separated from each other in three situations, in order to inclose certain organs, so that the mediastinum is divided into, first, the anterior part, or anterior mediastinum, which has been already examined; second, the middle part, or middle mediastinum, which contains the heart and pericardium, with the phrenic nerves, the ascending aorta, and superior vena cava, the division of the trachea, and the pulmonary arteries and veins; and third, the posterior mediastinum, which lies in front of the vertebræ, and which the student may next examine.

The *posterior mediastinum* extends in a vertical direction from the third to the tenth dorsal vertebra, behind the pericardium and roots of the lungs, and in front of the spine; to obtain a view of the parts contained in it, draw the right lung forward, and to the left side, and make a perpendicular division of the right pleura, between the root of the lung and the spine. This region is described as being of a triangular form, the base posteriorly, the pleuræ forming its sides, and the pericardium its apex; like the anterior mediastinum, however, it has naturally no exact figure, the pleuræ being folded round the organs which lie between them. In the posterior mediastinum we find the œsophagus and eighth pair of nerves, the thoracic duct, vena azygos, de-

* Anat. Descrip. t. 2. p. 830.

† Diseases of the Chest, p. 460.

scending aorta, splanchnic nerves, several lymphatic glands, and a considerable quantity of fine, loose, cellular membrane; the division of the trachea is immediately in front of this space, just at its commencement. The *œsophagus* is anterior to the other parts in the posterior mediastinum; this tube having passed behind the left division of the trachea, enters this space, and descends obliquely forwards behind the pericardium and before the aorta; above, it lies to the right side of this vessel, but below it is to the left; in the lower part of its course it is surrounded by branches of the eighth pair of nerves, and, enlarging a little, it perforates the fleshy part of the diaphragm, opposite the ninth or tenth dorsal vertebra, and joins the stomach. The *eighth pair of nerves* having passed behind the roots of the lungs, attach themselves to the œsophagus, and form by their branches a plexus around it (*the œsophageal plexus;*) the left nerve then descends on the fore, and the right on the back part of this tube to the stomach.

The *thoracic aorta* enters this region about the fourth or fifth dorsal vertebra, and descends along the spine, to its left side above, but nearly in the mesial line below; about the eleventh or twelfth dorsal vertebra it passes between the crura of the diaphragm into the abdomen; in this course the aorta furnishes the following branches: two or three bronchial arteries, which go to the lungs, as many œsophageal branches, and nine or ten pair of intercostal arteries, whose name implies their destination.

The *vena azygos* commences in the abdomen by a small branch from one of the superior lumbar veins, enters the thorax behind the right side of the posterior mediastinum, covered by the right pleura; and opposite the third or fourth dorsal vertebra it arches forwards over the root of the right lung, and opens into the superior vena cava, as that vessel is entering the pericardium. The vena azygos in this course receives the bronchial, œsophageal, and intercostal veins; those of the left side often unite into one branch, which, passing behind the aorta, joins opposite the sixth or seventh vertebra, the principal trunk on the right side.

The *thoracic duct* also commences in the abdomen, on the second or third vertebra behind the aorta, in a sinus, called receptaculum chyli; contracting in size it enters the posterior mediastinum, along with, and to the right side of the aorta; it ascends close to this vessel, between it and the vena azygos, imbedded in fat, and opposite to the fifth or sixth dorsal vertebra it attaches itself to the back of the œsophagus, runs obliquely along it, behind the arch of the aorta, to the left side, and ascends in the neck behind the left carotid artery and jugular vein, as high as the sixth cervical vertebra; it then bends downwards and outwards, and enters the left subclavian, just before it joins the jugular vein. The coats of the thoracic duct are so fine and thin, that frequently it is difficult to see or trace this vessel, unless previously injected or inflated from the abdomen; it is often found divided into two or three branches which unite again. (For a more particular description of it, see *the Anatomy of the Absorbent System.*) The *splanchnic nerves arise* by four or five filaments from the dorsal ganglions of the sympathetic nerve; the first is from the fifth or sixth ganglion, the rest arise in succession below it; all unite and form the splanchnic nerves, which descend obliquely forwards on each side of the aorta, along with which they enter the abdomen, where each terminates in a large ganglion, termed *semilunar;* these two ganglions are joined together by numerous branches, which constitute the *cœliac* or *solar plexus*, from which the greater number of the abdominal viscera are supplied with nerves. In the dissection of the posterior mediastinum, the sympathetic nerve is also seen on each side; it does not lie in this space, but descends external to it, between the pleuræ and the heads of the ribs; opposite each intercostal space it forms a ganglion, from which some branches pass to join the dorsal spinal nerves, others to form the great splanchnic

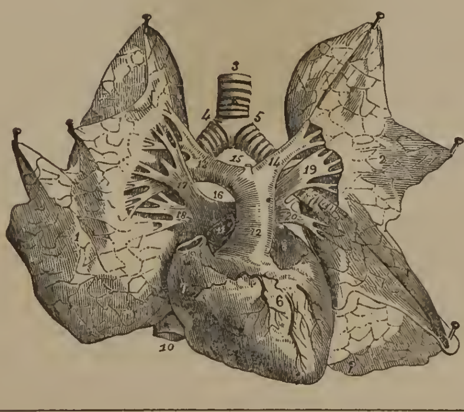
and at the lower part of the thorax, two or three filaments often unite to form a small nerve, called *lesser splanchnic*, which enters the abdomen, behind or through the crura of the diaphragm, and joins the renal plexus of nerves. The sympathetic on each side enters the thorax close to the neck of the first rib, where it forms a large ganglion; it passes from this cavity by a very small filament, between the crus of the diaphragm and the psoas magnus, into the abdomen, where it again enlarges considerably. (See *the Anatomy of the Nervous System.*) The division of the trachea, the last part of any importance connected with the posterior mediastinum, does not, strictly speaking, lie in this space, but, like the heart and great vessels, it is in the middle mediastinum, or between the anterior and posterior; this tube can be more conveniently examined afterwards, when we are dissecting the parts which pass through the upper opening of the thorax. Next examine the lungs.

The *lungs* are situated at either side of the spine, and, when distended with air, as they constantly are during life, they so exactly fill each side of the thorax that the pleura pulmonalis and costalis are always in such perfect apposition, that there never can be any intermediate cavity; they are of a conical figure, the apex round and often irregularly bulged, when distended rises into the neck to a height varying from one to two inches above the level of the first rib, which bone occasionally indents it anteriorly; the apex of the right usually rises higher than that of the left; the base concave, particularly of the right, accurately moulded to the convexity of the diaphragm, presents an inclined plane from before backwards, hence the vertical diameter of the lungs is much longer behind than before; the diaphragm is so convex on the right side, that a sort of angular gutter exists between it and the ribs, particularly behind; into this the lung fits exactly, by a thin, prolonged margin; this conformation is less evident on the left side; it depends on the position of the liver, the convexity of which raises the diaphragm into the corresponding concavity in the base of the lung; this close apposition of the liver, diaphragm, and lung, explains how a wound, penetrating the right side of the chest, so high even as the fourth intercostal space, may also open the abdominal cavity, and thus injure, at once, the two layers of the pleuræ, the lung, and the diaphragm, also the two layers of peritoneum, and the liver; it also accounts for sympathy in disease, and the difficulty in diagnosis, as also for the occasional discharge of hepatic abscess into the right pleura, or into the bronchial tubes of the right lung. The posterior edge of the lung is long, thick, round, and vertical, it fills the concavities of the ribs at each side of the spine. The anterior edge is much shorter, is thin, irregular, and oblique, that of the left lung presents two notches, a small, narrow one above, corresponding to the left subclavian artery, and a large open one below, opposite the apex of the heart; the anterior edge of the right lung also presents two notches, but smaller, the superior corresponds to the descending cava, the inferior to the right auricle. The external surface of each lung is convex, corresponds to the pleura costalis, and presents a deep fissure, which commences below and behind the apex, descends obliquely forwards, and ends in front of the base; it divides each lung into two lobes, one superior and anterior, the other larger, inferior, and posterior; the base of the latter is the base of the lung, that of the former is above at the apex of the organ. This interlobular fissure penetrates to a great depth, and its opposed surfaces are smooth and serous; from the middle of that on the right side, a short fissure leads forwards to the anterior edge of the lung, and cuts off the middle lobe from the superior; this does not penetrate so deeply as the great fissure, it is sometimes absent, and in some it exists on the left lung also; occasionally there are four lobes in the right, and three or four in the left, and examples are recorded of even five or six, the ordinary conformation in many other

animals. The internal surface of each lung looks towards the mediastina, and is attached to the heart by its root, anterior to which, this surface, particularly on the left side, is concave for the reception of the pericardium and its contents.

The *root* of each lung is situated a little above the centre of the internal surface, and about two-thirds from the anterior edge; the phrenic nerve and a few filaments of the pneumogastric nerve, which form the small anterior pulmonary plexus, lie anterior to it, and the great pulmonary plexus is posterior to it; the fold called ligamentum-latum is below it. The superior cava, and the right auricle of the heart are in front of the root of the right lung, and the vena azygos bends round its upper margin; the arch of the aorta is above that of the left side, and the descending aorta is behind it. Each root consists of several vessels and nerves connected together by cellular tissue, and all inclosed between the laminæ of the pleura; dissect off this membrane from the forepart of the root, and we shall observe the two pulmonary veins inferior, but anterior to the pulmonary artery, which is immediately above and behind them; posterior and superior to the artery is the bronchial tube; a quantity of cellular tissue connects these vessels, and contains the bronchial arteries and veins, lymphatic vessels and glands, also several nerves, which are derived from the pulmonary plexus. In the root of the left lung the bronchial tube is rather inferior to the artery, but still posterior to it, as on the right side. The function of the several parts in the root of each lung is as follows: the two pulmonary arteries convey from the heart, through the lungs, the dark and venous blood; the four pulmonary veins return to the heart this blood changed into bright arterial; the two bronchial tubes distribute the air through the lungs; the bronchial arteries small, three or four on each side, arise from the aorta, these, together with lymphatic vessels, and the nervous filaments, from the pneumogastric and sympathetic, are distributed through all parts of these organs, on the parietes

Fig. 23.*



* Anterior view of the heart and roots of the lungs; the lungs are separated from each other, and drawn outwards. 1. The right lung. 2. The left lung. 3. The inferior portion of the trachea. 4 The right bronchus. 5. The left bronchus. 6. The anterior surface of the heart. 7. The right auricle. 8. The appendix of the left auricle. 9. The superior vena cava. 10. The inferior vena cava. 11. The aorta, cut across a little above its origin. 12. The trunk of the pulmonary artery. 13. The right pulmonary artery. 14. The left pulmonary artery. 15. The ductus arteriosus. 16. The superior edge of the left auricle. 17 and 18. The superior and inferior pulmonary veins of the right side. 19 and 20. Superior and inferior pulmonary veins of the left side.

of the air tubes, and in the interlobular cellular tissue, for the purposes of nutrition; the corresponding bronchial veins open into the vena azygos, or into some of the intercostal veins.

The lungs have a peculiar soft, emphysematous feel, and are so light as to float in water; their color is gray, interspersed with spots of dark blue or blackish tint; the younger the subject the redder they will be found; in the adult they are generally gray, and slightly streaked with dark lines inclosing polygonal spaces; in the old they are usually mottled with blue or black spots, which exist, not merely on the surface, but through their substance. The lungs are composed of the ramifications of the pulmonary arteries and veins, of the bronchial arteries and veins of the pulmonary nerves, of lymphatic vessels and glands, and of the ramifications of the bronchial tubes, which end in numerous air-cells, the latter, together with their connecting cellular tissue, constitute the principal bulk of the lungs. These cells are collected at first in clusters, and joined by cellular membrane into lobules; these last are again united

Fig. 24.*

into larger masses by the pleura, so as to form lobes. The air-cells are the terminations of the bronchial vessels; they are of an irregular form, are lined by mucous membrane, and covered by a delicate, fibrous, or, as some suppose, a muscular lamina; each bronchus divides into two branches, these again subdivide into two, and so on in binary order, thus increasing in number, but diminishing in size; their final capillary branches end in small cœcal sacs or air-cells; if any one bronchial tube be inflated, these small cells and lobules become observable on the surface, marked out and bounded by depressed bands of interlobular cellular tissue, and it is principally in these lines, and at their angular junctions, the dark streaks and spots already mentioned may be observed; the larger bronchial tubes are composed of the same materials as

* The lower part of the trachea. and the left bronchus laid open (Reisseisen). 1. The orifice of the right bronchus. 2. Longitudinal and elastic fibres. 3. The mucous membrane. separated from the longitudinal fibres. 4. Transverse muscular fibres exposed by the removal of the mucous membrane and longitudinal fibres. 5. The pulmonary artery injected and cut across.

the trachea, but in the smaller branches there is no cartilaginous structure. On the delicate parietes of the latter, the fine capillaries of the pulmonary arteries and veins are spread, and here during life is effected that important change in the blood, from venous to arterial, which appears to be the great design of the function of respiration. As to the minute structure and exact arrangement of the air-cells, it is difficult to speak with confidence, Reisseisen and others maintain that each cell is but the globular dilatation of the ultimate ramification of a bronchial tube, like the cells or cœcal extremities of the excretory ducts in the secreting glands, and that each lobule is an aggregate or group of cells, connected together and attached to a bronchial tube and its ramifications, like a bunch of fruit attached each by its own pedicle to the stalk, and that these cells communicate, not directly, but through the common tube from which their ducts proceed, and through which the atmosphere enters their cavity. Although an inspection of the fœtal lungs encourages this view, yet it is by no means confirmed in those of the adult; here the cells appear far more numerous than the ramifications of the bronchial tubes can even be supposed to be, and, therefore, some anatomists believe that each fine tube does not end in a single cell, but that it leads to a cluster of cells which communicate with each other. My own observations on this minute structure, not merely in man, but in many other animals, lead me to concur in this opinion. Addison (*Phil. Trans. note,* 1842), conceives that Reisseisen's account is correct as regards these organs in the fœtus, that is, that the tubes there end, each in a cell or cœcal sac without adjacent communications, but that after respiration a change occurs; the feeble membrane composing these cells, becomes distended laterally into rounded inflations, new cells become moulded by angular pressure, and communicate freely with each other, the septa being incomplete, being mere filaments or laminæ; this open, reticulated texture in a single lobule, is analogous to the arrangement through the whole organ in some of the class reptilia.

Thus we may regard each lobule as a small, but perfect lung, possessing its air tubes and its bloodvessels, and capable of performing its functions, and often even exhibiting isolated disease, independent of the adjacent lobules; the interlobular cellular tissue is fine and reticular, never contains adeps, but is permeable to serous and emphysematous effusions; these lobules are of variable size and shape, those towards the surface are the largest, and are pyramidal or wedged-shaped, those deeper seated are of irregular figures, but accurately adapted to each other; the cells in each lobule are generally said to be globular, but they have no determined form, some are larger and more permeable to the air than others; they are small in the fœtal lung, and larger in the old than in the adult, and larger above than below; in chronic cough they are often dilated, and when very much so, they constitute the disease called pulmonary or vesicular emphysema, an affection very different from the cellular or interlobular emphysema; the air cells and smaller air-vessels are very thin, and possess a very delicate texture, although they exhibit much power of resistance in the injection or inflation of any part of the lung; they are composed of mucous membrane, covered by a cellular and fibrous tissue, but there is no evidence of any muscular structure, the bloodvessels lie between the contiguous walls of two of these air tubes and air cells, so that the capillary streams are exposed on all sides to the influence of the air.

The spongy and yielding tissue of the lungs admits of the free entrance and rapid circulation of the air through their cells, all which become distended in the moment of inspiration; in this act the lungs are wholly passive, the air distending them in the exact proportion with which the parietes of the chest are expanded; in expiration, the contraction of the thorax expels a great portion of the air from the cells, and thus the lungs become diminished in capac-

ity; in effecting this change, the elasticity of these organs, aided by the muscular energy of the bronchial tubes, may assist the muscular and elastic power of the parietes of the chest. In expiration the air-cells are not wholly emptied, as no power can completely discharge the air from lungs that have once breathed.—See *Anatomy of the Diaphragm and Trachea*.

The pleuræ and lungs are the seat of many *morbid* changes; the pleura, when inflamed, becomes thickened and vascular, and presents a deposit of lymph on the surface, which commonly causes an adhesion between the pleura costalis and pulmonalis to a very variable extent; when these adhesions are recent, they are soft and easily broken, but when of long standing they become strong and resisting: adhesions of different extent and length are very common appearances. Portions of the pleura costalis are found sometimes converted into bony plates. Such deposits, when extensive, resemble the natural condition of the ribs in the turtle and the tortoise; this deposit takes place in the fibrous, not in the serous tissue; it occasionally occurs also in the pleura pulmonalis, which corroborates the statement of the fascia existing there also, and apparently without having caused any inflammation or inconvenience. The cavity of each pleura is also the seat of effusion; if of water or serum, it is named hydro-thorax; if of air, pneumo-thorax; if of pus, empyema; the operation of paracentesis, or tapping, is frequently required in the latter case. The place usually selected for this operation is about midway in the fifth or sixth intercostal space, just in front of the digitations of the serratus magnus.

The lungs are often found in a state of inflammation (pneumonia); this is denoted by increased density, weight, and color, sometimes dark, sometimes very florid; the affected portion is often so heavy as to sink in water; the dark color, from the gravitation of blood to a depending part, must not be confounded with that arising from disease. Inflammation sometimes ends in gangrene, and sometimes in abscess, which may open into the trachea or into the pleura, and so cause empyema. The lungs are very subject to tubercles, which present great variety in size, from a pin's head to that of a walnut; when small they are firm, when large they become soft, suppurate in the centre, and form abscesses or vomicæ, which often communicate with the bronchial tubes. Tubercles are often found in the upper part of the right lung, when the remainder of both organs is healthy. The lungs are also occasionally the seat of cancerous and fungoid tubercle and tumor. We shall next direct our attention to the parts passing through the upper orifice of the thorax.

Posterior to the deep cervical fascia, we perceive the sterno-hyoid and thyroid muscles first ascending through this opening; behind these is a quantity of cellular membrane, and the remains of the thymus gland; next are the *right* and *left venæ innominatæ*, the former descending perpendicularly, the latter obliquely across the opening: these two veins unite opposite the first intercostal space or the cartilage of the second rib of the right side, and form the superior vena cava, which soon enters the pericardium, and empties itself into the right auricle. The venæ innominatæ are formed by the confluence of the internal jugular and subclavian, opposite the sternal end of each clavicle; the *right* is about an inch and a-half long, descends almost vertically, inclining a little inwards towards the mesial line, parallel, but superficial and external to the arteria innominata; at its commencement it is joined by the right absorbent trunk, afterwards by the vertebral, and in general also by the internal mammary and inferior thyroid veins of the right side. The *left* is much longer and a little larger, runs across this opening almost transversely, but descending a little towards the right side, is convex forwards, is covered by the sterno-clavicular joint, the upper border of the sternum, the sternal muscles, and a strong layer of cervical fascia, a lamina of which connects it to the thoracic septum and to the pericardium; it crosses over the three large arte-

ries, and the trachea, and receives at its origin the thoracic duct, and in its course the vertebral, mammary, and inferior thyroid veins of the left side, also the superior intercostal, the phrenic, thymic, mediastinic, and sometimes also the right mammary and thyroid. The superior cava is smaller than the united innominatæ, about three inches in length; descends along the right side of the mediastinum, inclining mesially, so as to be convex towards the right side, is separated from the right lung by the right pleura and the phrenic nerve, which from being external becomes rather anterior to it; the aorta is anterior and to its right side, and the remains of the thymus and cellular tissue are in front of it; opposite the upper edge of the third costal cartilage it enters the pericardium, the serous layer of which is reflected down upon it and covers its two anterior thirds, or fourths; posteriorly this portion of the cava is in contact with the pulmonary artery and superior pulmonary vein in the root of the right lung; opposite the point of serous reflection, the vena azygos enters it posteriorly, occasionally, also, small branches from the adjacent parts join it in its descent; its course and relations in the pericardium shall be considered presently in the description of the heart. Behind the venæ innominatæ, the phrenic and eighth pair of nerves enter the chest; the former is external and anterior to the latter, and both are anterior to the subclavian arteries. The *phrenic nerves*, accompanied for a short distance by the internal mammary vessels in front of which they cross, descend through the thorax, anterior to the roots of the lungs, to the diaphragm, to which they are distributed; the *right* descends vertically along the right vena innominata, cava and pericardium, in front of the root of the lung, and to the right of the inferior cava to the diaphragm; the *left*, as it descends to the chest, lies external to the left carotid artery, and in front of the par vagum, crosses the side of the arch of the aorta, to the median line of that nerve, and reaches the pericardium, on which it takes a curved course, convex to the left, around and behind the apex of the heart, it is therefore longer, and on a plane somewhat posterior to the right; a small artery, from the internal mammary, accompanies each of these nerves. *The eighth pair*, entering the chest between the subclavian vein and artery, pass backwards behind the roots of the lungs, on which they form an extensive plexus, *pulmonary plexus;* they then enter the posterior mediastinum, and become attached to the œsophagus, which conducts them to the stomach. We next perceive the innominata, *left carotid*, and *left subclavian* arteries, ascending out of this cavity; the innominata is most anterior, and the left subclavian the most posterior of the three; the cardiac nerves are connected to these arteries. The *trachea* enters the thorax, behind these vessels, and inclines a little to the right side; this tube commences opposite the fifth cervical vertebra, descends at first in the middle line, but as it enters the chest it inclines to the right, the aorta pressing on its left side, a little lower down; in the thorax it descends obliquely backwards, and opposite the third dorsal vertebra divides into the right and left bronchial tubes; a number of dark lymphatic glands (the *bronchial glands*), of very irregular form, lie in the angle of the division, and adhere closely to the branches. Its average length is about five inches; but as it admits of elongation, and possesses considerable elasticity, it varies in this respect according as the neck is extended or flexed; the loose cellular tissue around it permits free motion longitudinally, and even laterally, which latter circumstance, in the operation of tracheotomy during life, has proved a source of difficulty and danger; its diameter varies according to age, sex, and general development of the respiratory organs; it is larger in man than in woman; the transverse exceeds a little the antero-posterior diameter, as it deviates from a cylinder, the posterior third being flattened; in this respect it differs from the cricoid cartilage, which is nearly circular, and which in other respects it equals, though in many instances I have known the trachea to exceed it in capacity;

in the adult male the transverse axis is between half and three-quarters of an inch; it is sometimes a little contracted at first, or about the third or fourth ring, and it is frequently enlarged just above the bifurcation; in some it gradually enlarges as it descends, so as to assume a conical form, the base below; it is very variable in this respect; some have remarked both general and partial dilatation, in persons afflicted with severe cough; such alterations in diameter are remarkable and normal in many of the bird tribe. The cervical and thoracic portions of the trachea are nearly of equal length; the relations of the former are as follow: the first ring is superficial; the second, third, and often the fourth, are covered by the middle lobe of the thyroid body, which adheres closely; below this, the cervical fasciæ and the sterno-hyoid and thyroid muscles cover it, especially the latter, which being connected together by a sort of raphe derived from the deep fascia, prevents its being even distinctly felt; behind these muscles is a considerable quantity of cellulo-adipose membrane, containing the venous plexus of the inferior thyroid veins, in their descent to the left vena innominata; a small artery (middle thyroid) frequently traverses this plexus; near the root of the neck the arteria innominata passes in front of it and to its right side, rising to a variable height; the left vena innominata also crosses it nearly on a level with the upper border of the sternum. On either side of the trachea in the neck we find the lateral lobes of the thyroid body, the sheath of the carotid artery, lymphatic glands, and much cellular and adipose tissue; its flat posterior surface rests on the œsophagus, but towards the bottom of the neck the latter projects to the left side, and supports the left recurrent nerve; the right recurrent is behind the trachea.

The proximity of the œsophagus to the flat and membranous surface of the trachea accounts for the danger of suffocation from any large substance becoming impacted in the former, and the necessity for performing tracheotomy if it cannot be dislodged. This posterior flattening of the trachea has been thought by some to have been designed to facilitate deglutition, by admitting the distension of the œsophagus; however, the same structure is continued in the bronchi, where no such intention could apply; and in some animals the cartilages are perfectly annular, and in others they even project behind in an angular form. In the thorax, the trachea is between the lungs and pleura, just above and in front of the posterior mediastinum; anterior to it are the sternum with its muscles, the remains of the thymus body, much cellular tissue, and the arteria innominata; the left carotid is also in front and to its left side, a little lower down the arch of the aorta rests upon its anterior and left aspect; the division of the pulmonary artery is immediately in front of the left bronchus; these relations to the great vessels are of great interest and importance, in accounting for many of the symptoms, as well as the fatal results of aneurism of the aorta, or of any of the large arteries in this situation; posteriorly the trachea still rests on the œsophagus, on either side are the pleura and the pneumogastric nerves, and at its very entrance into the chest the recurrents also; much cellular tissue and many lymphatic glands surround it, continuous with similar structures in the neck.

The trachea, which serves as the free passage for the air to and from the lungs, and therefore requires to be permanently open, is composed of different tissues, viz.: fibrous, cartilaginous, elastic, mucous membrane, with glands and muscular fibres. The fibrous membrane is the essential basis; it forms the continued tube, is attached above to the cricoid cartilage, divides below into the two bronchi, and is continued along their ramifications through the lungs as far, probably, as their terminations in the air cells: in this tissue the annular cartilaginous plates are deposited very close to its inner or mucous surface; the average number of these is eighteen, each forms about three-fourths of a circle, the posterior deficiency being supplied by the fibrous membrane and

transverse muscular fibres; each cartilage is convex anteriorly and externally, and covered by the fibrous membrane, concave posteriorly, and lined by mucous membrane; their upper and lower margins are thin, attached to and inclosed in the fibrous tube; their extremities are blunt points; as to size they are very irregular, often larger in one part than in another, they are not, therefore, always parallel: two are sometimes partially united, occasionally one or more will be found bifurcated; the first ring is deeper than the others, particularly in front, and is sometimes continuous with the cricoid; the two last rings are also larger than those that preceded them; the last serves as the transition from the single tube into the two bronchi, it is very deep in front, and bent backwards so as to form an angular projection into the trachea between the two bronchi; the semicircular edges of this curved portion form the first cartilage in each bronchial tube. The tracheal cartilages resemble those of the nose and external ear, much more than the laryngeal; they are thin, yielding, and compressible, but very elastic and difficult to break or injure; they are rarely ossified; in very old men I have found the first and last thus partially changed, as also specks of calcareous deposit, but not true bone, in the anterior convexity of several, not unlike the appearance so often found in the middle coat of an artery. These cartilages maintain the trachea in a state of permanent patency, whilst at the same time they admit of expansion and contraction; they also prevent its closing from accidental pressure, or from the weight of the atmosphere during inspiration, which then tends to compress it, at which time the deep cervical fascia and the sterno-thyroid muscles also afford it considerable protection. The muscular structure of the trachea is found posteriorly where the cartilaginous is deficient; it may be exposed by dissecting off the fibrous membrane, or by first opening the trachea in front, and then raising the mucous; it consists of distinct transverse fibres, pale and thin, attached to the extremities of the cartilages; by their contraction they can diminish the size of the trachea, as also resist forcible expansion in violent expiratory efforts; in some cases of chronic bronchitis these fibres have been found hypertrophied. Between the muscular and mucous coat the yellow elastic tissue exists in the form of longitudinal bands, at first view like the folds of the mucous membrane, but they are not effaced by distension; they adhere closely to the membrane, but can be separated by dissection, and traced into the bronchial tubes; similar bands are also sometimes found beneath the cartilages; this elastic tissue maintains the due length of the trachea, it admits of extension, but resists excessive elongation, and restores it to its former state. The fibrous membrane on the front and sides of the trachea occasionally presents a reddish appearance, like longitudinal muscular fibres, but none such exist in the human trachea. The mucous membrane is continued from the larynx, lines the trachea, the bronchial tubes, and all their ramifications through the lungs, also the air cells in which they terminate; it adheres very closely to the interior of these vessels, and in the trachea it is pale, fine, and thin, nearly transparent, and perforated by many small foramina, orifices of the mucous glands, which are numerous in the parietes of this tube. These glands are found in three situations; first, on the posterior flat surface of the trachea and connected to the fibrous membrane, are several of a flattened, ovoid shape, these are the largest; secondly, between this membrane and the muscular fibres, also in the interstices of the latter, we find almost a regular layer of these bodies; and lastly, between the edges of the cartilages beneath the fibrous coat, also between the former and the mucous lining a number of very small ones may be detected; these glands, no doubt, furnish that fine muco-serous secretion which constantly coats the surface of the membrane and defends it from the irritation of the air.

The arteries of the trachea are derived chiefly from the superior and infe-

rior thyroid; the veins are superficial and deep, the latter are subjacent to the mucous membrane posteriorly and laterally, and receive branches regularly from each annular interstice; they open into the adjacent veins; the nerves are derived from the pneumogastric and recurrents.

The two *bronchial tubes* separate at an obtuse, or nearly a right angle; a strong, elastic, triangular ligament occupies the angle of bifurcation, and limits their separation; their united areæ exceed that of the trachea. The right tube is the larger, as the right lung exceeds the left, it takes a short and nearly transverse course into the root of the right lung, above and behind the right pulmonary artery, having the vena azygos curved round it from behind upwards and forwards; it soon divides into three branches. The left bronchus is smaller but much longer, and passes obliquely downwards into the root of the left lung, behind and below the level of the left pulmonary artery, and divides into two branches; in this course it passes through the arch of the aorta, embraced by it above, and in front of the œsophagus, thoracic duct, and descending aorta. Both bronchi are intimately connected to the great pulmonic plexus of nerves, and to several lymphatic glands, which are usually, in the adult, of a very dark color and soft consistence, and are frequently in a diseased or altered state, indurated into a mass, or converted into a cheesy or calcareous substance; the pneumo-gastric andthe left recurrent nerves will be often found imbedded in or surrounded by these morbid structures. The pulmonary arteries in the root of each lung, at first anterior to, gradually rise above the bronchial tubes and then pass behind them; the veins at first are between the tubes and arteries, but as they approach the heart are placed below and in front of both. In form and structure the bronchi resemble the trachea; flattened and deficient in cartilage behind, they possess all the other tissues in common with it; the right one possesses five or six annular pieces, the left nine or ten. Their arteries are divided from the bronchial branches of the aorta, and their veins open into the azygos or intercostals. As the bronchi proceed into and through the pulmonary tissue important changes occur; they rapidly branch off into numerous ramifications, diverging in every direction, and therefore difficult to follow individually to any extent; each branch first divides into two, each of these again into two, and so on, as far as we can pursue them, they adopt this dichotomous division and subdivision, though occasionally supernumerary branches arise and separate at acute angles; finally, the small terminating tubes lead each to a separate lobule, and each ends in a free communication with its air cells or vesicles; these air vessels are accompanied throughout by the pulmonary arteries and veins; the former are very close to and usually behind them; the veins are more loosely connected; these different vessels can be recognized on the surfaces of a section of the lung. The air vessels very soon lose the form and structure of the trachea and primary bronchial tubes; the fibrous and mucous coats continue through their entire course; the longitudinal elastic tissue soon disappears, but the cartilages are curiously modified and changed in a gradual manner; instead of forming large segments of a circle, they soon become divided into small curved pieces equally diffused round the whole tube, which now becomes cylindrical; these segments are of the most varied forms, and are bounded by edges and points which can mutually overlap and glide upon each other; the muscular coat is also continued circularly, and forms a thin, circular tunic, like that on the intestine; the fibres are attached to the margins and points of the cartilages; by this means the capacity of the tubes can be changed, particularly diminished, but not obliterated; this arrangement continues even in the smaller tubes, but the cartilages gradually lose the curved angular form, and are reduced in size to mere lines, patches, or grains, and, finally, at the last bifurcation of an air tube, a small cartilaginous tubercle stands in the angle of division; beyond

this, the tube is wholly membranous, and, as well as the cells into which it opens, appears to be composed of nothing more than the mucous lining and a fine fibrous investment. How far the muscular coat extends, whether it ends abruptly at the last cartilaginous tubercle, or whether it is continued, of great delicacy, over the final tube and air cells, it is impossible to speak with accuracy or confidence; it is probable, however, that as soon as the cartilages cease, the muscular structure which was designed to act on them, and thereby to alter the diameter of the tube, ceases also; but as to the final tubes and cells, there being no resisting medium in these, muscular structure might prove injurious rather than beneficial; the air once inspired ever afterwards retains these in a more or less distended condition, and cannot wholly be expelled during the healthy state of the organs, but is constantly undergoing a gradual change and gradual displacement, by the admixture of fresh air in each inspiration, and by the expiratory efforts.

The respiratory tube, from the glottis above, to the terminating pulmonary air vesicles below, presents a curious series of transition structures, each change being wonderfully adapted to a special purpose: the larynx, in one part, with its delicate and beautiful locomotive apparatus and voluntary endowment, and in another composed of the unyielding, and, of course, unchanging circular wall of the cricoid cartilage; the trachea and bronchi, with their crescentic and elastic plates, convex on all sides exposed to pressure, but deficient behind, and thereby capable of yielding to expansion, and recoiling by elasticity, aided by the transverse involuntary muscular fibres attached to their extremities; the pulmonary tubes, cylindrical and muscular, at the same time studded with a sufficiency of cartilaginous grains to prevent obliteration, and yet to admit of change of place and form; and lastly, the capillary air tubes and air vesicles, wholly destitute of these two elements. These modifications of structure in the different sections of this one tube, are not only interesting to the anatomist and physiologist, but are also of extreme importance to the pathologist, in connection with the nervous and structural diseases of the respiratory organs.

Behind the trachea, the *œsophagus* is next seen entering the thorax, lying close to the spine, or rather to the left longus colli muscle; its course is slightly tortuous, like an intestine, at first a little to the left of the mesial line, afterwards to the right of that line, and as it descends through the posterior mediastinum, it again inclines to the left and a little forwards. On the left side of this tube, the thoracic duct is seen ascending from the thorax into the neck, between the left carotid and subclavian arteries. As the œsophagus enters the chest, we observe on either side of it the recurrent nerve; that of the left side passes out of this cavity, that of the right arises on a level with this opening. The œsophagus is a musculo-membranous tube, extending from the pharynx to the stomach; it commences behind the cricoid cartilage, opposite the fifth cervical vertebra, and enters the abdomen between the crura of the diaphragm. In its cervical portion the trachea is anterior to it, also the left lobe of the thyroid gland, and the inferior thyroid vessels, and recurrent nerve of the left side; the sheath of the cervical vessels is related to it laterally; and it is surrounded by loose cellular membrane, which connects it to the longi colli muscles. In the thorax it soon enters the posterior mediastinum, where it has been already examined. It is composed of muscular, mucous, and cellular tissue; the muscular is very distinct, the fibres externally are longitudinal, internally circular; both are more distinctly marked than in the digestive canal below, excepting in the rectum, to which it bears some analogy; they are red above, pale below, and expand on the stomach; these fibres belong to the involuntary muscles; cellular tissue connects them to the mucous or lining coat, which is thin and pale, thrown into longitudinal plicæ. and lined by a fine epithelium or cuticle;

when the neck is much extended, the pharynx and œsophagus become nearly one straight line. On each side of the œsophagus, and at some distance, we perceive the *sympathetic* nerve entering the chest, posterior to the phrenic and the vagus, but between both; this nerve, having formed its inferior cervical ganglion, divides into several branches, which descend into the thorax; a few pass anterior to the subclavian artery, the principal pass behind it; most of these unite in its first thoracic ganglion, which is situated on the neck of the first rib; the sympathetic then descends along the side of the spine, passing over the heads of the ribs, and opposite each intercostal space forms a small triangular ganglion, from each of which two or three small branches proceed to join the dorsal spinal nerves, and from the five or six inferior the great and small splanchnic nerves arise; the sympathetic is so small inferiorly, that it is often difficult to trace it; it escapes from the thorax into the abdomen, beneath the true ligamentum arcuatum. Posterior to the œsophagus, the longi colli muscles ascend through the upper opening of the thorax; on each side of these lie the superior intercostal artery, and the anterior branch of the first dorsal nerve, ascending to join the last cervical in the brachial plexus. The apex of each lung and pleura also occupy this opening; that on the right side has in front of it the right vena innominata, the phrenic, pneumo-gastric, and cardiac nerves, the arteria innominata, and subclavia dextra; that of the left side has the left vena innominata, the corresponding nerves, the left carotid and subclavian arteries, and the thoracic duct; while posterior to each are the superior intercostal artery, the sympathetic, and the ascending branch of the first dorsal nerve. The parts which pass through the base of the thorax will be more properly considered in connection with the diaphragm, which they perforate; they are, immediately behind the sternum, the internal mammary vessels, and cellular tissue from the anterior mediastinum; the phrenic nerves near the centre; the vena cava to the right, and the œsophagus to the left of the mesial line, and posteriorly on each side of the spine the greater and lesser splanchnic nerves, and close to the vertebræ the aorta, vena azygos, thoracic duct, and sympathetic nerves. We shall next examine the heart and pericardium.

The *pericardium* is a strong fibro-serous membrane, in the form of a conical bag, whose base is below and apex above; it is larger than the heart, which it incloses, together with a portion of the great vessels connected to it, and over whose surface its internal or serous layer is reflected; the external lamina is composed of aponeurotic fibres crossing each other in a very irregular manner; the greater number of these fibres are longitudinal. This external, or fibrous layer, is connected, inferiorly, to the central division of the cordiform tendon of the diaphragm, and to some of its fleshy portion between the central and the left divisions of that tendon; anteriorly it corresponds to the anterior mediastinum and to the sternum, to which it is connected by cellular membrane, and to the cartilages of the fifth, sixth, and seventh true ribs of the left side, from which it is, however, separated by the left lung and pleura; posteriorly, to the œsophagus and to the other parts in the posterior mediastinum; superiorly, it is continued along the outer coat of the great vessels, while the serous layer is reflected on these towards the heart. On each side it is in a similar manner connected to the pulmonary vessels; the pleura and the phrenic nerve also are attached to it in this situation. The connection between it and the tendon of the diaphragm, particularly towards its forepart, is very intimate; in the adult they are almost inseparable, not so, however, in the fœtus. The large vessels passing to and from the heart perforate this parietal layer, the fibres of which are prolonged as a sheath upon them, and are gradually identified with their external coat; there are nine of such perforations; one for the aorta, two for the pulmonary arteries, four for the pulmonary veins, and two for the venæ cavæ; it sends no sheath on the

inferior cava. Open this bag, and we shall see that it is lined throughout by a smooth serous membrane, which, if we trace to the superior part of the sac, we shall perceive to be reflected on the vena cava on the right side, about an inch above its entrance into the right auricle, on the aorta in the middle, about two inches above its origin; and on the pulmonary artery on the left side, at nearly the same distance from the heart; on these three vessels it descends towards the heart; there is a longer portion of the aorta covered by the serous membrane, than of the vena cava or pulmonary artery, which two are nearly equal in this respect. The serous layer is reflected on the superior cava, opposite the entrance of the vena azygos; as it descends along that vessel it nearly surrounds it, except a small portion of it posteriorly: from the vena cava it continues to the right auricle, which it covers anteriorly and on the right side; from this it passes on the right pulmonary veins, covers these also partially, and is thence reflected to the fibrous layer; from the lower part of the right auricle it is continued partly round the inferior cava, and from it also it is reflected to the fibrous layer. On the aorta the serous layer descends at first on the forepart, afterwards on its sides and back part, so as to encircle it; near the heart it passes from it over the pulmonary artery, so as to connect these vessels to each other, leaving, of course, uncovered so much of each as is in apposition; along these vessels the serous membrane descends to the ventricles, and having covered all the anterior surface of the heart, from which it is separated by more or less of interposed adipose substance, it turns round its apex, covers the posterior surface, and ascending on it as high as the upper edge of the left auricle, it is thence reflected on the fibrous layer in front of the posterior mediastinum; from the left auricle also it extends to the left pulmonary veins, from which it is continued to the fibrous layer, and on this we can trace it in an uninterrupted course to that point, at which we commenced its description. These several reflexions of the visceral from the parietal layer, along the great vessels, represent processes with cornua or *cul de sacs,* especially when the vessels are empty; behind the united roots of the aorta and pulmonary artery it lines a smooth, transverse passage, or sinus, which is in front of the right pulmonary artery and the left bronchial tube, and above the fleshy basis of the heart; this sinus opens at each extremity into the general cavity, but has no direct communication with the great *cul de sac* which is formed posteriorly at the back part of the heart, between the left auricle and the posterior mediastinum. The arteries of the pericardium are small, and proceed from the aorta, innominata, internal mammary, phrenic, bronchial, coronary, and œsophageal; the veins correspond to the arteries, some terminate in the vena azygos.

The pericardium, by its fibrous lamina, is of *use* in fixing the heart in its situation, and strengthening its parietes, so as to resist over-distension; this fibro-serous membrane also, by its elasticity, may assist in the contraction of its cavities, while the serous layer, being always lubricated by a fine fluid, facilitates the motions of the heart. When the pericardium is fully opened, the right auricle, the two cavæ, the appendix of the left auricle, the right or anterior ventricle, that small portion of the left which forms the apex of the heart, the aorta, and pulmonary artery, also branches of the coronary vessels, ramifying on the anterior surface of the heart, all come into view.

The pericardium is liable to acute inflammation, pericarditis; opportunities do not often occur for observing the membrane in this condition, when it will be found crowded with minute vessels, carrying florid blood; it is also more pulpy and thicker than natural; extravasated coagulable lymph is found loosely connecting it to the heart; this sometimes has a reticulated or lace-like appearance, and portions of it float on the serous fluid which exists in the cavity. In some cases large quantities of pus are formed, without any appearance of

ulceration, but always accompanied with a thickened state, and a deposition of coagulable lymph on the internal surface of the membrane. The presence of a small quantity of fluid in the pericardium after death, is not to be set down as a morbid appearance, or confounded with the disease called hydrops pericardii, as in every healthy body a few drachms of fluid are found in the bag of the pericardium, arising from the condensation of the natural exhalation, which exists in all serous cavities, or from the transudation of the blood from the contraction of the heart after death.

The HEART, the central organ in the apparatus for the circulation of the blood, is a strong muscular bag, divided into four compartments, the right and left auricles, and the right and left ventricles, and is designed to receive and to propel the blood from and to all parts of the body. The heart is of great importance in zoological science, as upon its presence or absence, its simple or complex structure, many circumstances in the general organization of an animal depend. A perfect heart exists in all the vertebrata, but differently modified in the different classes. Mammalia and birds possess a perfect, single, but quadrilocular heart; in reptiles and fish it is much more simple, or bilocular, that is, it consists of a single auricle and ventricle, which latter in fish is wholly pulmonary, or branchial, but in reptiles is both pulmonary and systemic. This organ exists in mollusca also, but in a simpler or more rudimentary form; in some there are two, or even three separate hearts placed in different parts of the animal, to regulate and assist the circulation of its blood. In mammalia and birds, notwithstanding the heart appears as single, it is yet really double, and to a certain degree symmetrical, the right heart being connected with the venous and pulmonary circulation, the left with the arterial and systemic or aortic circulation; hence the synonymous terms, right or pulmonic heart, left or aortic. In man the right heart is also anterior to the left.

The heart is of a well-known form; the cone is not uniformly rounded, but is a little flattened anteriorly, as well as inferiorly, hence it presents distinct surfaces and edges, besides a base and apex. It is situated in the cavity of the thorax, near its centre, and corresponds to the union of the superior third of the body with the two inferior thirds; placed in the middle mediastinum, behind and a little to the left of the sternum, obliquely in front of the spine, between the lungs, and above the diaphragm, which separates it from the liver, stomach, and spleen; in this position it is maintained by the pericardium, the pleuræ, and the large vessels passing to and fro; it is, however, subject to slight changes of position from natural or healthy causes, such as change of posture of the body, as it reclines horizontally, or is bent forward, or to either side, also according to the different states of inspiration and of expiration; the condition of the stomach, and other abdominal viscera may also exert some influence in this respect. The heart is placed obliquely from above and from behind, downwards, forwards, and to the left side; the base looks upwards, backwards, and to the right, and corresponds to the front and right side of the mesial line of the fifth, sixth, and seventh dorsal vertebræ, it often extends in front of the fourth also, as well as of the eighth; the base lies obliquely across the spine, and is therefore well supported by it, though separated from it by the parts in the posterior mediastinum. The apex is directed downwards, forwards, and to the left side, corresponds to the costal end of the sixth rib; the lung being notched in this region, its pulsations can be felt through the fifth and sixth intercostal spaces, below the mamma. The axis of the heart, that is, a line traversing the apex, and centre of the base, has an oblique course from the point, upwards, backwards, and to the right side, or towards the right scapula. The heart, or rather the ventricles, present, for our more minute examination, three surfaces, anterior, inferior, and posterior; two edges, anterior thin, posterior thick; also the base and apex. The anterior sur-

face is the largest, flattened, and slightly convex, divided into two unequal parts by a longitudinal groove, which contains the left coronary artery imbedded in fat; there is a similar groove on the posterior surface, which also contains a branch of the left coronary artery; these two grooves correspond to the septum between the ventricles, and meet at the apex, and divide the heart into the right, or anterior, and the left, or posterior. That portion of the anterior surface to the right of the anterior line, or groove, is larger than the left, and is formed of the right ventricle; to the touch this feels soft and flaccid, and corresponds to the sternum, while the left portion is firm and resisting, and is composed of the wall of the left ventricle, and is opposite the left costal cartilages. On this anterior surface a small white spot, of variable size, is often to be seen, sometimes two or three, probably owing to the thickening of the serous or sub-serous tissue, the result of some slight inflammatory action.

The inferior surface is flat and horizontal, of a triangular shape, is formed of the right ventricle, and rests upon the diaphragm; this surface is distinguished from the anterior by the thin edge of the heart, but is gradually rounded off into the posterior; the latter is thick and convex, is formed of the left ventricle, and rests on the inner side of the left lung; it is separated from the anterior surface by the left or thick edge of the heart, but is so continuous with the inferior that they are regarded by many as forming but one surface. The edges of the heart are two; the inferior or anterior is thin and nearly straight, or horizontal: it extends from the inferior cava to the apex, and fits into the angle between the anterior and inferior portions of the pericardium. The posterior, or left edge, does not deserve that name; it is thick, rounded, and vertical, is formed by the left ventricle bending round from the front to the back part of the heart. The base presents from right to left the two auricular processes, and the roots of the pulmonary artery and aorta; the pulmonary artery arises on the right side of the anterior cardiac groove; that portion of the right ventricle from which it arises is prolonged upwards and a little to the left side, and, contracting into a funnel form, is named the infundibulum; the artery then passes backwards and to the left side; on a plane behind this is the root of the aorta from the left ventricle, at first concealed by the infundibulum and by the root of the pulmonary artery; this vessel soon emerges from behind the latter, and appears prominently to its rignt side, so that these two great arteries cross obliquely, like the limbs of the letter X; on a plane behind these we find a circular groove separating the auricles from the ventricles; with this the anterior and posterior vertical grooves communicate; this groove is very deep posteriorly, where it lodges the coronary vein and branches of the coronary arteries; at the bottom of it we see the fleshy base of each ventricle folded in, as it were, to present a broad surface of support to the auricles; this surface is cut off very obliquely from before backwards and downwards, so that the anterior surface of the heart is nearly an inch longer than the posterior; in front of the anterior part of this groove, the two great arteries spring, the aorta being posterior, and nearest to the groove. There is generally, but especially in old persons, a considerable quantity of fat in this groove, as also along the whole course of the coronary arteries. The apex of the heart is often curved a little backwards, is formed in the adult wholly by the left ventricle, but in the fœtus, the right also enters into it, hence, at this age, the point is rounder, and often a little bifid from the notch uniting the two vertical grooves; this notch in the adult is filled by fat, and requires dissection to unfold it, it then lies to the right side of the apex. The heart is larger, and more muscular in proportion in the child than in the adult; in the former, also, there is no fat upon its surface, and in the adult but little; but in the elderly it increases, particularly on the surface of the right ventricle, on the anterior thin edge, and in

the course of the coronary vessels; there is seldom any quantity of this deposit on the auricles.

The heart consists of four cavities, two ventricles and two auricles; these the student may examine in that order or course which the blood pursues in passing through this organ. Suppose the two venæ cavæ pour their blood into the right auricle, so as to distend it, the parietes of this cavity then contract, and empty its contents into the right ventricle; this next propels the blood into the pulmonary artery, the branches of which convey it through the lungs; from these organs it is returned by the four pulmonary veins, two on each side, into the left auricle; from this cavity it is forced into the left ventricle, which then propels it into the aorta, through whose branches it is conveyed to all parts of the body, whence it is again returned to the heart by the veins. The *superior vena cava* is seen descending obliquely forwards and inwards within the pericardium, and joining the upper and back part of the right auricle. Of the *inferior cava* but a short portion is seen within the pericardium; this vessel lies on a plane posterior to the superior cava, and passing obliquely upwards, backwards, and inwards, joins the lower and back part of the auricle; as these two veins have different aspects and are on different planes, the descending column of blood does not fall perpendicularly upon the ascending. Between these two veins the *right auricle* is situated; it is somewhat square; if distended it becomes convex anteriorly and to the right side, and concave posteriorly towards the root of the right lung, also internally towards the septum auricularum; its largest diameter is from right to left and from before backwards; it is broadest behind and below, and is prolonged anteriorly and superiorly into the appendix, or process called the auricle: this is loose and free, more or less serrated on its edges, turns forwards, and lies between the upper part of the right ventricle and the aorta. The right and posterior portion of the auricle is connected with the two cavæ, which are here continuous with each other, the expansion of the outer and posterior walls of which may, indeed, be regarded as forming this region of the cavity, and which, therefore, has been named the sinus of the auricle, or the sinus venosus; this division into sinus and proper auricle is more perfectly marked in the left auricle; the right auricle is connected inferiorly to the right ventricle, and partly rests on the diaphragm; on the right side it is free, and on the left it is connected to the left auricle; lay open this cavity by a perpendicular incision from the superior down to within half an inch of the inferior cava, from the centre of this make a transverse cut towards the anterior part of the auricle, wash out the blood; we may then observe at the back part of the sinus the *openings* of the two cavæ, and between these a slight projection, *tuberculum Loweri;* and in the auricular appendix the muscular fibres called *musculi pectinati.*

The opening of the superior or descending cava is at the upper and posterior angle of the sinus, circular, without any valve, and directed towards the passage into the right ventricle; a projecting muscular band separates it from the auricular process. The orifice of the inferior or ascending cava is larger, and on a plane posterior to that of the superior; it looks towards a remarkable depression, the fossa avalis, and is partially protected in front by the semilunar valve of Eustachius. The tubercle of Lower projects from the right and posterior aspect of the sinus, between the two cavæ, and opposite to the auriculo-ventricular opening, and just in front of the right pulmonary vessels; this was supposed to be of some use in directing the streams of blood from the two veins towards that opening, and preventing their perpendicular pressure against each other; it appears to be produced by a slight increase of thickness in that part of the wall of the sinus, together with a little fat externally, it is, however, very variable, and sometimes indistinct, or even altogether absent. The *musculi pectinati* are those muscular fibres which line

the anterior portion of the auricle and the appendix, internal to the venæ cavæ; the fasciculi pass from the auricle to the ventricular opening, chiefly in a parallel direction, leaving interstices between them, and from some fancied, but slight resemblance to the teeth of a comb, have been thus named; in these interstices there is no muscular fibre, and the investing and lining membranes are in such close apposition, that the blood can be seen through them before the cavity was opened, or if the cavity be perfectly empty, these interstices appear as whitish lines; hence the auricle always presents a striped or variegated appearance externally, whereas the sinus possesses a dense, muscular wall, and is therefore uniformly opaque. The musculi pectinati are crossed irregularly by smaller fasciculi, which give rise to a reticulated muscular structure, such as is seen on the inner surface of the ventricles.

The left or internal side of the auricle is formed by a thin sheet of membranous and muscular substance, the *septum auricularum;* on the inferior part of this we may observe a depression, the *fossa ovalis,* immediately above the inferior cava, and surrounded in part by a thick lip, named its annulus; at the upper and deeper part of this fossa we frequently find, even in the adult, a small oblique passage leading into the left auricle, its obliquity, however, prevents any communication taking place during life; in the fœtus before birth, this was a free opening, the *foramen ovale,* between the two auricles. Anterior to the opening of the inferior cava, we observe the semilunar fold of the lining membrane, the *Eustachian valve:* this valve is connected by its convex edge to the angle between the vein and auricle; its concave edge is loose, and looks backwards and to the right side; its superior cornu is connected to the anterior or the left limbus of the fossa ovalis, and the inferior to the forepart of the vena cava, and is sometimes continued round that vessel to the posterior limbus of the fossa ovalis; in the adult and old this valve is often reticulated and imperfect; in the fœtus it is generally more perfect and large; hence it is considered by many as being of *use* at that period in directing the blood from the inferior cava at once into the left auricle through the foramen ovale, and preventing its mixing with that from the superior cava. To the left side of the Eustachian valve, between it and the ventricle, is the *orifice* of the *coronary* sinus, a small thimble-like cavity with muscular walls, which is also partly covered by a semilunar fold of membrane, the free and concave edge of which is directed upwards; beneath this, open two or more of the coronary or cardiac veins; this fold, or valve, (*valve of Thebesius,*) secures these openings against the re-entrance of the blood during the contraction of the auricle; this valve is also often imperfect; on different parts of the auricle small orifices may be often seen (*foramina Thebesii;*) some of these are probably the extremities of small veins, others only lead into the muscular depressions; anteriorly and to the right side of the venæ cavæ, the auricle presents the pectiniform and recticular structure already alluded to; the latter structure is also continued through the auricular appendix, or process, which communicates by a free, circular opening with the general cavity: the distinction between the auricle and the appendix is not so well defined on the right as on the left side of the heart. Inferior to this process, and opposite the tuberculum Loweri, is the large orifice leading into the right ventricle; this, the *right auriculo-ventricular opening,* is circular, and surrounded by a dense white line, which is usually designated as the right tendon of the heart. We may next examine the right ventricle: for this purpose open its cavity, by raising the anterior wall in the form of a flap from below, making one incision along its right side, and the other near the septum cordis.

The *right ventricle* occupies the anterior, inferior, and right side of the heart; of a triangular form, its base is joined to the auricle and pulmonary artery, its apex is a little short of the apex of the heart; its walls are thicker

than those of the right auricle, but thinner than those of the left ventricle, it is also thinner towards the apex than at the base; its anterior and inferior walls are much thinner than the left or posterior, which is the septum ventriculorum, and which is thick, convex, and resisting, whereas the other sides are weak; hence the parietes of this cavity always feel soft and flaccid; they are rendered very irregular internally by numerous muscular projections, the *carneæ columnæ; some* of these are attached throughout their whole length, *others* are fixed by their extremities, and loose in their centre; these are the most numerous, they subdivide and form numerous areolæ; and a *third, musculi papillares,* are fixed by one end to the fleshy substance of the ventricle, by the other to thin tendinous chords which are attached to the auricular valves; the carneæ columnæ take various directions, and are all covered by the fine lining membrane of the heart, they form a very intricate network on the walls of the ventricle, and several cross the cavity; they are less numerous on the septum and at the base than near the apex. At the base of the right ventricle we observe the auricular and arterial openings; the latter is superior, anterior, and to the left side of the former; from the margin of the auricular opening a fold of the lining membrane descends into the ventricle; the inferior loose edge of this valve divides into three principal portions, each ending in a very irregularly notched margin, to which the chordæ tendineæ are attached; these are the *tricuspid valves;* one division is to the right side, the second is posterior, on the septum cordis, and the third, which is the largest, is anterior and to the left side, and separates the auricular from the arterial opening; this (the septum of Lieutaud) is supposed to act as a valve on the pulmonary artery, so as to prevent the blood entering it during the filling of the ventricle; many of the tendinous threads are connected to the dorsum, as well as to the edge of these folds, and cross each other as they run to the carneæ columnæ; some also are inserted into the septum; the edges of the valve are often studded with reddish tubercles. Most of the tendinous threads arise from the carneæ columnæ, or musculi papillares; though slender, they are very strong, and in their course to the valves they diverge, often bifurcate, and communicate together. The left, or anterior valve or curtain, is the largest, and prevents the filling of the pulmonary artery during the distension of the ventricle, or the systole of the auricle; the cords of this valve are inserted into a long fleshy column, which is attached to the anterior, or the yielding wall of the ventricle; from the lower part of this column a transverse muscular band passes across the cavity to the septum; the right curtain is connected by its cords partly to the long column, and partly to a second, which is also on the anterior wall; and the third valve has its cords inserted into the septum without any separate columns. The *use* of the tricuspid valves is to prevent the reflux of the blood from the ventricle into the auricle; as the former cavity is being distended, the blood separates the valves from the parietes of the ventricle, and thus becomes situated on their outer side; when the ventricle thus contracts, it presses the blood against these folds, which are thus approximated to each other, and slightly raised against the opening, so as to close it; the carneæ columnæ at the same time contracting, make tense the chordæ tendineæ, and thus accomplish two objects, first, they approximate the valves; and second, they prevent their being reversed, or thrown up into the auricle; if, however, the right ventricle be over distended, as a consequence of impeded pulmonary circulation, the anterior more yielding wall will carry with it the columns and cords of the anterior and right valves, and thus effect an opening or passage between them, whereby the blood may regurgitate into the auricle, and thus the ventricle will be relieved; this mechanism is said to answer the purpose of a safety valve:* another useful purpose also may have been designed in

* See Essay by T. W. King, Guy's Hospital Reports, vol. ii.

this peculiar attachment of this valve, namely, that the complete diastole of the ventricle shall clear the opening into the artery which has been closed by this curtain during the distension of the cavity.

The orifice of the pulmonary artery is small, situated at the highest point, and at the left extremity of the ventricle, anterior to, and nearly an inch to the left side of the auricular opening, from which it is separated by a prominent concave muscular ridge, and by the septum of Lieutaud; these divide the ventricle into two chambers, an auricular, which is extremely irregular, from the reticular cellular net-work formed by the carneæ columnæ, and an arterial, which is smooth and polished. Around the root of the artery the ventricle is prolonged into a sort of process, named from its form the *infundibulum*, or *conus arteriosus;* out of this the artery springs, being attached to the ventricle by, first, the reflected layer of the pericardium, continued a short distance upon the artery, and connected to it by cellular tissue; second, by the lining membrane being continued from the ventricle into the artery; and third, by the attachment of the middle, or yellow elastic coat of the vessel, to the firm fibrous zone, or ring, which surrounds and constricts the arterial opening. This, the *right arterial tendinous zone*, stands on a plane oblique from above and without downwards and inwards, the outer edge of its upper surface is therefore the higher; it is dense and firm, like fibro-cartilage, and appears composed of three semilunar roots, convex towards the ventricle; the cornua are blended together, and thus one continuous circle is formed with three triangular projections towards the artery; the intervals between these festoons are completed by the two serous membranes, with an intervening lamina of fibrous tissue, strong, but so thin as to be translucent. The muscular fibres of the ventricle are inserted into the lower surface of these convex roots, and into the fibrous tissue in their interstices. The middle coat of the artery is connected to the outer edge of the tendinous zone, and to its anterior projections by three semicircular roots; this connection is very close, although there is a manifest distinction between the tissues; those fibres of the artery that are connected to the projecting cornua of the festoons form a distinct curved line, in passing from point to point, while below this they are thinner, weaker, and, of course, shorter, and correspond to three small dilatations, or sinuses, in the artery, named sinuses of Morgagni, or Valsalva; internal to each of these sinuses is a semilunar or sigmoid valve. The *sigmoid valves* are three in number, one is anterior, another posterior, and to the left, and a third is to the right side; occasionally there are but two, and very rarely four; they consist of a duplicature of the lining membrane with some fibrous tissue inclosed; each is attached by its convex edge to the inner lip of the upper surface of the fibrous zone, and strong tendinous fibres are inclosed in this situation; in the concave edge also is a distinct tendinous thread, beneath the centre of which is that small, white, or yellowish corpuscle, named corpus Arantii, which thus divides this free margin into two short lunated portions; between the concave and convex borders of each valve, finer tendinous threads exist, curving from the corpus Arantii, to the border of the festoon. The tendinous structure in the sigmoid valves is more developed in the aorta than in the pulmonary artery; so also are the sinuses external to the valves.* Each of these sinuses may be described as bounded thus: externally by the thin, bulging, convex, fibrous root of the artery; internally, by the sigmoid valve; inferiorly, or towards the heart, by the narrow, oblique upper surface of the tendinous zone; while superiorly or anteriorly it is open in the direction of the artery. These sinuses are better developed in the old than in the young. The sigmoid valves, though thin and

* See "Heart," by J. Reid, and "Aorta," by J. Hart, in Todd's Cyclop. of Anat. and Physiol., also Anat. Generale, by Beclard.

transparent, are strong and resisting; as their action is perfectly mechanical, they are named passive, in contradistinction to the auriculo-ventricular, which, as requiring muscular agency, are denominated active valves. Their *use* is to prevent the reflux of blood from the pulmonary artery to the right ventricle. As the blood flows into the vessel, the valves become vertical, and are pressed towards the sides of the artery, not, however, into close contact with them, as the pulmonic sinuses, which always contain some blood, are external to the valves; in proportion as the diastole of the artery is perfected, the valves are more vertical and more separate from the walls, and the sinuses become fully distended; when the systole of the artery occurs, the blood is pressed backwards and inwards towards the ventricle, the valves are thereby approximated to each other, and are thrown horizontally across the calibre of the artery, towards which they are concave, while towards the ventricle they are convex, the opening into which is thereby closed, and only so much blood is forced backwards as lies between the valves, or towards the axis of the passage; it has been thought by some, that the very axis is closed by the meeting of the three tubercles of Arantius; this opinion, however, is not confirmed by careful examination, for if we imitate their supposed condition during life, we shall find that the valves do not become perfectly horizontal, but that the edges rather overlap or press against each other; these tubercles also are often very indistinct; in the young they do not project even to the edge; they are, probably, intended to give additional strength in the axis of the opening, where the reflux force will be most sensibly felt; they may also serve as a fixed point for the tendinous threads inclosed in the folds.

The *pulmonary artery* ascends obliquely backwards for about two inches within the pericardium, and just as it escapes from this cavity it divides into the right and left branch; in this course it is convex forwards and to the left, lies at first anterior to the aorta, and then crosses over to its left side. The *right pulmonary artery* is the longer branch; it turns in a transverse direction to the right side, anterior to the right bronchus, and passes through the arch of the aorta, behind the superior cava, to the root of the right lung, and there divides into three branches. The *left pulmonary artery* is short, proceeds to the left side, and, entering the root of the left lung, anterior, and rather superior to the left bronchus, divides into two branches; from the division of the pulmonary artery a ligamentous cord extends backwards and downwards, in the direction of the primitive trunk, to the lower extremity of the arch of the aorta; this is the remains of the *ductus arteriosus*, which in the fœtus conveyed the blood from the pulmonary artery into the aorta, as it could not pass in any quantity through the condensed structure of the lungs; the recurrent, or inferior laryngeal nerve of the left side winds round this substance. The pulmonary artery is composed of the same number of tunics as the aorta, but the fibrous coat is much weaker, therefore this vessel, when empty or divided, collapses. In the lungs the pulmonary arteries divide into numerous branches which accompany the bronchial tubes and pulmonary veins, the artery in general above and behind, and the vein below the bronchial vessel; finally, the capillary terminations spread minutely on the air cells in innumerable ramifications, from which commence the pulmonary veins; these unite with each other, and form larger trunks, which arrive at the root of the lungs, two on each side, where they lie anterior and inferior to the pulmonary arteries; these veins then pass inwards to join the left auricle; those of the right side are concealed by the right auricle and superior vena cava, and open into the right side of the cavity; the left veins are shorter, and open into the left side, a little nearer to each other; a few fleshy fibres are continued on these vessels from the auricle, which cavity may be next examined.

The *left auricle* is situated at the upper and back part of the base of the heart, in front of the posterior mediastinum; it may be exposed either by

raising the apex of the heart, or removing this organ from the body, and placing it on its anterior surface; like the right, it may be divided into the sinus venosus, and the auricular appendix or process; the sinus is somewhat square, smaller than the right, but its parietes are thicker and stronger, and therefore more opaque; from its anterior, upper, and left extremity the appendix passes forwards, and overlaps the origin of the pulmonary artery; this appendix is longer, more curved, and irregularly notched than that on the right side, and communicates by a well-defined opening with the general cavity. Open this chamber by a perpendicular incision along its posterior part in the middle line; internally we perceive it smooth, except in the appendix, where a few fleshy fasciculi appear, as in the right side; the posterior wall is flat, and corresponds to the œsophagus in the posterior mediastinum; the right side is the septum auricularum, a slight depression in which, not so distinct as that in the right auricle, marks the former situation of the foramen ovale; the four pulmonary veins are seen opening into the angles of this cavity, two on each side; those of the right are immediately behind the septum, those of the left open very near each other, and sometimes in common, beneath the opening of the appendix; at its inferior and anterior part we perceive the opening into the left ventricle, circular, smooth, and marked by an opaque, dense, white line, as in the right auriculo-ventricular opening, than which this of the left side is somewhat smaller.

The *left ventricle* occupies the left and posterior regions of the heart, and forms the principal bulk of the organ; of a conical form, the base above shorter than the right ventricle by the length of the infundibulum; its point forms the apex of the heart and extends beyond the right; it is a little longer, and apparently, though not really, smaller; its walls feel firm and resisting, and do not collapse, though empty. Continue the incision already made in the left auricle, downwards through the posterior wall of this chamber to its apex, and we shall perceive the superior thickness of its parietes, excepting near the point, where, especially in old persons, they are very thin; a fact which accounts for rupture of this cavity generally occurring in this situation; the septum cordis appears to belong to this ventricle, and is concave towards it, so that this chamber appears pushed or received into the right, particularly at the upper part, from the overlapping of the infundibulum, but not so below or at the apex; the interior is not so much, or so deeply reticulated as the right, except near the point, where it is very much so. This cavity presents also the three species of carneæ columnæ; the musculi papillares are very large, but only two or three in number; they arise low down near the apex, one from the posterior wall, near the septum, the other from the junction of the left and posterior wall; they ascend, and about the middle of the cavity end in blunt points, often bifid, and sometimes trifid; to these the chordæ tendinæ are attached, which also are stronger and thicker, but fewer in number, than those in the right; some few of these threads merely pass from one papillary muscle to another; the others extend to the two valves of the auricular opening; some of these divide and are inserted into both curtains, and from each of the muscles chords pass to both valves, so that they interlace; they are attached not so much to their margin as to their dorsum, or ventricular surface, on which they form an expanded interlacement, and contribute much to their strength; from this net-work some of the chordæ tendinæ pass up to the margin of the auricular opening, and are inserted into its tendinous zone. The walls of the ventricle are smooth above towards the base, in which are seen the openings of the auricle and of the artery; the latter is small and directly in front of the former, and, like that of the pulmonary artery, is furnished with three sigmoid valves. The auricular opening is much larger, a little to its left side as well as behind it; and, like that in the right ventricle, though smaller, is also provided with folds or curtains,

which, however, are only two in number, and are named the *mitral valves;* the auricular and aortic openings are very close, the anterior mitral valve only intervening; this is so joined to the base, or origin of the adjacent or posterior sigmoid valve of the aorta, that if these two valves be removed the base of the ventricle will then present but a single orifice. The auricular opening is in the upper and back part of this cavity, of a circular or rather oval figure, its long axis transverse, and therefore nearly at right angles with the axis of the right auricular opening, which is longer and directed from before backwards; it is surrounded by a white and dense tendinous zone, from which a fibrous expansion descends, inclosed in the valvular duplicature of the lining membrane; the latter soon divides into two principal segments, one anterior and a little towards the right, the other posterior to this foramen and somewhat to the left; the anterior mitral valve is much larger, and directly intervenes between this and the arterial orifice, and, like the septum of Lieuteaud, in the right ventricle, divides this also into an auricular and an arterial chamber, and which can only communicate below this valve; this larger curtain also is supposed to answer the purpose of preventing the influx of blood into the aorta during the diastole of the ventricle; this object, however, is also secured by the aortic valves, for during the ventricular diastole the artery is in a state of systole, and, of course, is closed by the sigmoid valves, which are then across the mouth of the vessel. The posterior, or left curtain, is shorter and more fixed, as one or two tendinous threads pass from its dorsum to the wall of the ventricle; both these curtains are strengthened not only by the fibrous expansion they inclose, and by the tendinous interlacement on their ventricular surface, but also by containing, particularly the anterior one, firm cartilaginous tubercles, and even not unfrequently bony laminæ, the former near their margin, the latter near the base. The mitral valves are stronger and more efficient as such than the tricuspid, and their office is analogous: as the blood descends into the ventricle, they are separated from the axis of the opening, and the larger is pushed beneath and across the mouth of the aorta; as the diastole of the ventricle is perfected, the blood fills every recess, and, of course, occupies the spaces between the valves and the walls of the cavity; in the systole of the ventricle they are approximated, and the papillary muscles, which must also contract, draw these curtains closer and closer, so as gradually to convert the opening into a narrow conical passage, the apex below, and finally to close it, while at the same moment that leading into the aorta is opened freely for the entrance of the fluid. The contractile efforts being directed upwards towards the base, accounts for the thinness of the apex contrasted with the muscular wall in the centre and above; at the same time it explains why, in cases of obstruction to the circulation, from any morbid cause, the former usually yields, and not unfrequently ruptures of a sudden. The opening of the aorta is directly in front and a little to the right of the auricular; leading to it, the surface of the ventricle is smooth, white, and polished; within the contracted orifice are seen the three semilunar valves, one anterior, another to the left, and the third to the right side. The attachment of the aorta to the ventricle, and the structure of its valves and corresponding sinuses, are so perfectly similar to those of the pulmonary artery, which have been already so minutely examined, that it would be superfluous to repeat the description of such analogous parts; it is only necessary to observe, that all the tissues in the aorta are stronger, the tendinous ring from which it springs is more distinct and prominent, the sinuses of Valsalva, or Morgagni, more developed, the sigmoid valves larger and thicker, and the corpora Arantii in particular are much more prominent. Above the free margin of the anterior and left sigmoid valves are the orifices of the right and left coronary arteries, the nutrient vessels of the heart; if we press the valves against the sides of the artery, into that position in which we may

suppose them placed in the systole of the ventricle, we shall find that they do not close or cover the mouths of these vessels, we may therefore infer that the coronary arteries of the heart are filled synchronously with all the branches of the aorta. The root of the aorta is implanted into the anterior angle between the two auriculo-ventricular tendinous zones, and its posterior half is intimately connected to both; its anterior portion is directly over the septum ventriculorum, which at this spot is thin; the root of the aorta occupies a portion of that space which intervenes between the origin of the pulmonary artery and the right auriculo-ventricular zone, while that of the pulmonary artery from the infundibulum is superior, anterior, and a little to its left side; these two roots are very close together, being only separated by the upper thin edge of the septum cordis; in a horizontal section of the heart made on a level with the base of the ventricles, when the organ has been removed from the chest, the four great openings will be found to have the following relations to each other from the right to the left side: first, the right auriculo-ventricular; second, the aortic; third, the pulmonic, also on a plane anterior to all; and fourth, the left auriculo-ventricular; and as the auricles are posterior to the ventricles, their openings are behind the arterial, and their zones are conjoined towards the mesial line, while the arteries springing from the forepart of the ventricles appear to issue more from the centre of the heart, the auricular sinuses being behind, while the appendices bending forwards overlap them in front. In the common central point of attachment, between the root of the aorta and the two auricular tendinous rings, we find a dense, compact, fibrous, and even sometimes a cartilaginous tissue, of somewhat a semilunar form; this serves as a firm and incompressible point of support for these three great openings, and of attachment and action for the muscular fibres. It is in this very situation in the larger ruminantia that we find a distinct and perfect bone is placed; and in the same place, too, we not unfrequently detect in the very aged heart of man, earthy and perfect ossific deposits, which sometimes extend even into the mitral valves, particularly the anterior one, and, if small, without impairing their mobility; one example, among many others that might be adduced, of abnormal appearances in the human subject being, as it were, repetitions of, or degenerations into forms and structures which in other animals are the normal and the determined conditions. It has been just before observed, that the roots of the aorta and the pulmonary artery are very close together, the superior edge of the septum ventriculorum alone intervening; in the very young embryo this septum does not exist; it commences below and increases upwards, unlike the septum auricularum, which descends, assisted by the valve of the oval hole which rises from below. The last part of the septum cordis to be formed is the upper edge which is immediately beneath the two great arteries; previous to the development of this septum, these vessels arise by one common tube, and this by the growing and ascending septum ultimately becomes subdivided into the pulmonary artery in front, and the aorta behind. These facts explain certain irregularities in these parts which we occasionally find in the infant, still more rarely in those of maturer years, such as a communication between the ventricles; when this exists it is found at the upper part of the septum, and may be considered as the result of some delay or arrest in the growth or completion of this partition; the same explanation will account for the aorta in some cases arising by a double origin, or rather springing out of both ventricles, as also for the aorta and pulmonary arising by a common stem, or though rising distinctly, yet having a communication close to their roots. These and many other deviations from the established plan, and which may be regarded as abnormal, when found in the matured fœtus, and which are usually incompatible with any long-continued independent existence, were yet, however, in all cases, at an earlier period, their actual, though but their

transient condition; and it appears equally interesting to remark, that many of these peculiar conditions which are only temporary in the fœtus, and which are considered abnormal when continued in the adult, are, in most of the class Reptilia, the normal, the permanent, and the necessary arrangements.

The *aorta* at its origin is covered by the infundibulum and the pulmonary artery; it ascends obliquely forwards and to the right, as high as on a level with the cartilages of the second rib of each side; it then passes backwards, and to the left side; and lastly, decending as low as the fourth dorsal vertebra, it becomes closely attached to the spine; this portion of the aorta is called the *arch*, at the termination of which this vessel receives the name of thoracic or descending aorta, which descends through the posterior mediastinum, as was already stated. The *arch of the aorta* is divided into the ascending, the transverse, and the descending; the first is the longest portion, and in general is so much dilated at the upper and convex part as to have received the name of the *great sinus;* this *ascending* portion is within the pericardium, covered at first by the pulmonary artery, it afterwards lies between this vessel and the vena cava; from the commencement of this the two coronary arteries arise; the *middle* or *transverse* portion of the arch lies above the pericardium and in front of the trachea; from it arise the innominata, left carotid, and left subclavian; the *descending* portion bends behind the root of the left lung, and is connected to the pulmonary artery by the remains of the ductus arteriosus; through the arch of the aorta, the right pulmonary artery, left bronchus, and left recurrent nerve pass.

The heart is composed of several tissues: first, the reflected serous layer of the pericardium; secondly, the muscular fibres which constitute the greater portion of the organ; thirdly, tendinous and fibrous structures, which are only found at the four orifices in the heart and in the four sets of valves connected therewith; fourthly, a fine lining membrane, in many respects resembling the serous membranes; and fifthly, the common elements of all organized parts, viz., cellular tissue, vessels, and nerves. The external serous membrane has been already described; it is thicker, and more easily admits of separation on the auricles, and on the roots of the large vessels, than on the ventricles.

The inner membrane is termed the *Endocarde ;* it may be traced from the entrance of the two venæ cavæ, the inner coat of which it forms, into the right auricle which it lines throughout, forms the Eustachian and the coronary valves, is smooth and polished, and adheres to the muscular fibres by such a close and fine tissue, as to be difficult of demonstration; it then passes through the right auriculo-ventricular opening, adheres closely to its fibrous boundary, increases in density, and forms the loose, pendulous valve, named tricuspid, from the root of which it is expanded over the inner surface of the ventricle, of such extreme fineness as to be perfectly transparent, involving all the carneæ columnæ and coating all the areolæ between these; as it approaches the orifice of the pulmonary artery it is stronger, adheres to the line of its origin, assists in forming the sigmoid valves, and becomes continued into the lining internal coat of that vessel and of its ramifications. In like manner, through the left cavities of the heart, we can trace it from the pulmonary veins into the left auricle, thence into the left ventricle and aorta, forming in its course the mitral and the sigmoid valves. The endocarde is thicker in the auricles than in the ventricles, and more so in the left than in the right; its smooth and polished appearance causes it to be ranked as a serous membrane, with some characters, however, peculiar to itself. It serves to connect the muscular fibres together, and, in the auricles especially, to complete the walls in their interstices; by its duplicatures it also forms the curtains in the valvular apparatuses at the different openings, while its smooth surface facilitates the passage of the blood through the chambers of the heart, and

prevents its adhering to any of the irregularities they present; analogy renders it more than probable (though difficult to determine) that this membrane, not only in the heart, but through the whole vascular system, exhales some fine vapor which must facilitate the circulation of the blood.

The structure of the heart and the roots of the large vessels are supplied with blood by the two coronary arteries, the openings of which from the aorta have been already noticed as just above the edge of the anterior and left sigmoid valves and sinuses; these vessels can be traced without much dissection; dividing the infundibulum will expose their origin, and their course is seen by removing the serous membrane and the cellular and adipose tissue in the cardiac grooves.

The *right coronary artery* supplies the right auricle, the posterior part of both ventricles, and the thin edge of the heart; it *arises* from the forepart of the aorta, above the anterior sigmoid valve, and appears between the infundibulum and the right auricle, sinks into the auriculo-ventricular groove, winds round to the back part, sending a long branch along the anterior thin edge of the heart which reaches to the apex, and then, opposite the posterior vertical groove, it ends in two branches; one descends in this groove along the back of the septum to the apex, and forms a vertical circular inosculation with the left coronary; the other continues round in the superior sulcus, and, meeting the left artery, forms a superior circular inosculation at right angles with the former; this horizontal coronary inosculation is partly concealed by the trunk of the great coronary vein.

The *left coronary artery* is somewhat smaller; it supplies the left auricle, left ventricle, and the septum; its origin is concealed by the infundibulum, but it soon appears between this and the left auricular appendix, descends a little to the left, and divides into an inferior and superior branch; the latter is the smaller, it winds round in the auriculo-ventricular sulcus to the back part of the heart, and meets the circular branch of the right; the other branch, which is inferior, anterior, and the larger, descends tortuously in the anterior vertical groove as far as the apex, where it joins the branches from the right; in this course it supplies the left ventricle and the septum cordis; the coronary arteries communicate freely and frequently, not only in the two circles already mentioned, but by numerous branches on the aorta and pulmonary artery, on the surface and in the substance of the parietes of the heart. These arteries are frequently found spotted with calcareous grains, and sometimes as contracted rigid tubes; in such cases the muscular structure of the heart appears pale, flaccid, and atrophied; they also often present a flattened and a whitish aspect; sometimes they appear a little dilated and very tortuous, and surrounded by serous infiltration; I have seen them slightly varicose; in an old person they are usually imbedded in fat.

The *cardiac veins* do not exactly correspond to the arteries; there is but one considerable vein, and this does not accompany either artery through its entire course. The cardiac veins are great and small.

The *great* or the *coronary vein* commences in a number of small branches about the apex, ascends in the anterior vertical groove, receiving anterior cardiac branches, both superficial and deep, and, increasing in size, it turns round the base of the heart, first to the left and then to the back part, lying in the left auriculo-ventricular sulcus, superficial to the superior arterial circle; in this situation it receives posterior cardiac branches, auricular, ventricular, and interventricular, and appears oftentimes so dilated as to have received the name of coronary sinus; it then opens into the posterior inferior part of the right auricle, to the left of the inferior cava, being previously dilated into a sort of ampulla; the opening is concealed by a semilunar valve, beneath which the orifice may be seen in a sort of smooth, deep sinus, and close to it very frequently are two or three other small venous openings. In

the vertical part of its course it receives both deep and superficial branches from the ventricles and their septum; in its circular portion it receives a very large branch (the left cardiac vein), which ascends from the apex along the left side, then, passing backwards over the corresponding artery, joins it at right angles; the coronary vein next receives several branches from the back part of the left auricle, and from the back of the left ventricle; a considerable one, also, from the septum cordis joins it near its termination, but frequently opens distinctly into the auricle in the same sinus and beneath the coronary valve.

The *small cardiac veins*, which are two or three in number, also one from the anterior edge of the heart (the vena Galeni), are situated on the anterior surface of the right ventricle, and often open separately into the lower part of the auricle; these veins return the blood from the anterior surface of the organ, while the great coronary returns it from the left and posterior regions, from the septum, and partly also from the anterior or right surface of the heart. The cardiac veins want valves except the single semilunar fold in the right auricle, but this is seldom a perfect valve; injections can very generally be made to pass from the cavæ through the auricle into this vein, and so fill all its branches; during life, however, the contraction of the surrounding muscular fibres may assist this valve in closing the subjacent sinus against regurgitation; this point, however, may be considered as doubtful, for the valve is often defective, and the circular portion of the vein is occasionally found considerably dilated; in such cases, most probably, regurgitation may have occurred during life, as it does in the venæ cavæ, especially if there have been any obstruction to the pulmonary circulation.

The *nerves* of the heart are derived from the sympathetics, par vagum, and recurrents; the branches arising from these different sources are soft and gray; they all converge to the concavity of the arch of the aorta, and form, in front of the trachea, the *cardiac plexus*, which is a very entangled network of filaments, usually inclosing one or more masses of small, irregularly-shaped ganglions; the chief cardiac nerves arise on either side of the neck from the superior, middle, and inferior cervical ganglions, and are named accordingly the superior, middle, and inferior cardiac nerves; they are, however, very irregular in number and size, and often so indistinct as not to conform to any given description; frequently there are only two on the left side; these nerves are joined above by many delicate filaments from the par vagum, and lower down by several large branches from the recurrents. From the great cardiac plexus pass off two principal divisions, each of which forms a plexus surrounding either coronary artery; these are named the *coronary plexuses*, right and left; the latter is the larger, and supplies the left side of the heart; they consist of numerous very fine filaments which accompany the ramifications of the arteries, and can be traced as white lines, on the surface of the heart, beneath the serous membrane, for a considerable distance from the base towards the apex, and finally they enter into the muscular structure along with the capillaries, by such minute fibres, that the eye cannot determine their exact mode of termination; the greater number are distributed to the ventricles, and but comparatively few to the auricles; if the heart have been previously boiled or macerated in spirits, their course can be more easily traced. (See *Nervous System*.)

The fibrous and tendinous tissues in the heart have been already partially noticed; they exist at the four orifices, in the valves, and in the chordæ tendineæ; they form a sort of framework or foundation for the attachment of the two great arteries, and for the support of the muscular structure. Each auriculo-ventricular opening is surrounded by a strong tendinous zone, to which the muscular fibres of the auricle are attached above, and those of the ventricle below; that of the left side is stronger than the right, both are stronger

and broader on the ventricular than on the auricular aspect, and the plane of each is oblique from before backwards and downwards ; from each an expansion is derived, which is inclosed in the mitral and tricuspid valves, and which imparts to them considerable strength and resistance ; the right margin of the left ring is closely connected to the aortic zone.

The tendinous rings surrounding the arterial openings have also been already described ; they are, of course, smaller, but they are firmer than the auricular, and the aortic is more so than the pulmonic ; each circle is smaller than the circumference of the artery immediately above ; from these also, tendinous expansions proceed, six in number, that is, one into each semilunar valve, and one into each of the angular spaces between the thin fibrous roots of the artery ; connected with the auriculo-ventricular valve also are the tendinous chords from the carneæ columnæ ; these present all the characters of true tendons ; they are inclosed in the fine membrane of the ventricles, and are very distinct on the dorsum of the valves, at the root or fixed edge of which they are inserted into the tendinous rings ; some of these fibres often present a reddish appearance, probably only from being stained by the blood, at first view resembling muscular fibre ; and some have supposed that such really exists in these valves, and that it even becomes occasionally much developed in certain diseases of the heart ; however, the most careful examination fails to detect any such muscular structure in a satisfactory manner in the human subject, though in some of the larger animals it is manifest, and in birds one division of the tricuspid valve is wholly muscular. Tendinous fibres also exist, and have been already noticed in the arterial valves.

Muscular tissue is the principal component of the heart, and constitutes its most essential element ; the heart, in fact, is a hollow muscle, or rather two hollow muscles, one auricular, the other ventricular ; these are distinct and independent of each other, and each of these again is subdivided into two, a right and left, which, in the perfect organ, are separated by distinct septa, so that the heart is truly quadrilocular ; the septa are formed of two laminæ of endocarde, with an intermediate muscular stratum derived from an inflection of fibres from the walls ; the ventricular septum is very thick and eminently muscular, the endocarde being as nothing ; it appears to belong to the left ventricle, and is convex towards, or, as it were, pushed into the right ; the auricular septum is much thinner, contains but little muscular tissue, and is chiefly composed of the lining membrane, the two laminæ of which are very distinct and strong ; this septum appears to belong to the right auricle rather than to the left, and is convex towards the latter. The cardiac muscles are usually regarded as appertaining to the involuntary class ; in point of function they do so in an eminent manner, as during health and rest they act without our consciousness, but in structure they present peculiarities which distinguish them from both the voluntary and involuntary ; thus, in respect of color and consistence, they exceed the involuntary, and equal, if not surpass, most of the voluntary ; the latter also they resemble in possessing a distinct tendinous structure, which serves as a fixed ponit of attachment, or of origin and insertion, and some of the fleshy fibres end abruptly in the tendinous ; many of the fasciculi also have a parallel course, as in the voluntary, yet again they constantly intermingle and alter their direction, as do those of the involuntary muscles ; the fibres and fasciculi are much more intimately united to each other than those in either class, and the mode of their connection constitutes one of the most striking peculiarities : in all other muscles of either class the fasciculi are attached together by cellular tissue ; but in the muscles of the heart there is so very little of this common vinculum, that the close connection of their fibres must depend partly upon their compact juxtaposition, and partly upon their complex interlacement. Cellular membrane is seen on the surface and edges of the organ, particularly on the an-

terior, also around the nutrient vessels in the vertical grooves, and in the deep circular auriculo-ventricular channel; in the latter it penetrates deep to the tendinous zones, as the fleshy fibres above and below this line are perfectly distinct; but along the vertical cardiac grooves it is confined to the vessels, and does not pass to any depth, there being only an indentation, but no separation or division of the muscular structure. It is not difficult to understand the design, and to perceive the special relation of this peculiar condition; this close intertexture of a considerable mass of muscular fibre in the walls, and the absence of any passive yielding material, impart a certain elasticity and a degree of strength well adapted to resist over-distension, while the alternate relaxation and contraction effected by this uniform structure, is peculiarly well-suited to its functions; the cellular tissue found more or less in all other muscles, admits of motion between the fasciculi themselves, and allows one portion of the muscle to contract, while another is relaxed; but in the heart the whole of each muscle must and does contract at once; the fibres which inclose each ventricle, and those which connect both, act at the same moment; the two ventricles, with their valve muscles, and septum, being synchronous in action; and so the fibres proper to each auricle, with the connecting fibres of both, act synchronously, and there can be no partial action or partial relaxation either in the superior or inferior cardiac muscle. From this peculiar disposition of cellular membrane on the heart, we can explain the appearances which adipose deposits present, and which here, as in all other situations, have this tissue as their nidus and support; on the heart fat is often deposited, particularly in advanced life, and is found where the cellular tissue exists, in the circular and vertical grooves, in the course of the bloodvessels, and on the surfaces, especially the anterior, but not between the muscular fasciculi or on their internal surface; in some instances the walls of the right ventricle appear converted into fat, but the deposit has either increased from the surface, or the structure appears to have been altogether changed, the muscle becoming soft and oily, as if it were partially dissolved or degenerated into this substance; this change is very seldom found in the left ventricle or in the septum cordis; we may conclude, therefore, that the cardiac muscles cannot, in compliance with mere systematic arrangement, be placed in either class, but must stand alone, being muscles "sui generis," formed and endowed in a special manner and for a special purpose. The muscular fibres of the heart cannot be traced in the ordinary progress of dissection; the organ must be prepared with care, and much time devoted to the examination; the student will require at least two human hearts, one very young, the other adult, also the heart of an ox and calf, and of a sheep and lamb; these must be washed free from blood; the serous and cellular membrane, vessels, and nerves removed as fully as possible; they should then be boiled for a short time, then macerated and partially dissected, then boiled and macerated again; by repeating these processes with care, the structure will become loosened, though the fibres are hardened, and the latter may be separated, so as to render the course and arrangement of the fasciculi tolerably evident.

The *muscular fibres of the auricles* are independent of those of the ventricles, and are much fewer in number, hence these chambers feel weak and flaccid when contrasted with the latter; these fibres are attached to the upper narrow border of the auriculo-ventricular tendinous rings, also to that of the aorta; they consist in some situations of two planes, a superficial and a deep; the first is common to both auricles, the latter is proper to each; these two, however, are not separate, distinct, and perfect throughout; wherever any of the superficial fibres are deficient, some of the deep layer will supply their place, and frequently the fibres of one lamina, by a change in direction and course, will become a portion of the other. The superficial or

common lamina consists of fibres, mostly transverse, thinly expanded over the right auricle, and attached to its tendinous ring; they pass across the septum auricularum to envelope the left, and to connect both; on their anterior walls these transverse fibres are very distinct and strong behind the ascending aorta, towards which they present a marked concavity, and to which some fibres are usually attached; towards the borders these fibres expand and separate to inclose rather than cover the appendices, and to admit the entrance of the great veins; along the septum some fibres bend inwards into it, and surround three-fourths of the oval fossa like a sphincter; in the valve itself a few muscular fibres may be detected: this layer is very weak on the right auricle, much stronger on the left, and most distinct on the front of each. If these superficial transverse fibres be carefully divided over the septum auricularum, and the handle of the knife insinuated into the posterior groove, we may, with much care, separate the auricles and divide the septum, provided it be complete, into two distinct portions; we shall then perceive the form and relative thickness of each, as also how the septum belongs to the right more than to the left, and the right auricle is convex towards the left and pushed into or received by it.

The deep muscular fibres are proper to each chamber, and are connected to the lining membrane; arising from the aortic and auricular zones, they mostly take a circular course round the transverse axis, many, however, pass off obliquely or in a ramose manner; some enter the septum, some become superficial, others encircle, like sphincters, the pulmonary veins, and form loops around and between them, also round the entrance into the left auricular appendix, and interlace with the superficial fibres, especially in their appendices, where their plexiform ramifications produce the peculiar reticulated texture, leaving interstices, wherein the internal and external serous membranes are in contact; the course and the irregular ramifications of these fibres are best seen from the interior of the auricles, arising from the tendinous circles the columns ascend in different directions, and soon divide and subdivide; communicating and intertwining in a manner unknown in any other muscular structure, except, perhaps, in the muscular coat of the urinary bladder, which, in this one respect, bears a remote analogy to this arrangement.

The action of the auricular muscles must be towards their fixed points, namely, the tendinous rings; they will, therefore, contract those chambers, in all directions, and urge their contents through the large openings into the ventricles; it is doubtful whether they affect the venous openings; their arrangement on the pulmonary veins would incline to the opinion that their contraction may partly propel their blood into the auricle, and during the systole of the latter may also constringe their openings, so as to prevent regurgitation into them: the annular fibres also in the septum may, at an early age, assist the valve in the more perfect closure of the foramen ovale.

The muscular structure of the two ventricles constitutes the principal portion of the heart, and gives to it its peculiar form and consistence; these fibres, like those of the auricles, are divisible into superficial or oblique, and deep or circular, these can generally be made tolerably distinct and separate by dissection; the superficial are common to both cavities, and the deep are proper to each, so that (as Curveilhier observes) the ventricles are two distinct sacs, inclosed in a common sac (vol. iii. p. 25). The superficial fibres are very long, and disposed in laminæ or bands which can be separated and raised off one another, not, however, completely, as fibres pass to and fro connecting them together, and crossing or intersecting them obliquely: none of these fibres are perfectly vertical, or perfectly transverse, they are all oblique, and the superficial are more so than the deeper; none of them are superficial through their entire course, but only as they descend; they become deep or in-

ternal as they ascend; many of the fasciculi are of great length, arising from one part of the auricular tendinous ring, then, descending to different distances, they ascend, many of them, to be again attached to the same structure. The most superficial fibres on the anterior surface arise from the inferior broad margin of the auricular tendinous ring, descend obliquely towards the left as far as the apex; here they interlace with the corresponding fibres from the posterior surface, which, though more vertical, also descend obliquely to the right; they then ascend internal to the deep fibres, some terminate in the mammillary muscles, others ascending in the septum, and in the internal wall of the left ventricle, are again inserted into the auricular ring; all these bands are common to both ventricles, being superficial in one, and deep-seated in another, and proceed in this spiral manner, and are broader near the base than the apex of the heart; the superficial are longer than those deeper-seated; the ascending and descending portions of each form arches or loops, convex towards the apex, and concave upwards, and each incloses a similar but shorter loop in succession, hence the walls are thicker in the base and centre than at the apex. As the superficial oblique fibres from both surfaces converge to the apex, they present in it a curious twisted vorticose appearance, both set interlacing and then ascending on the inner surface of the parietes, or in the septum; thus the apex in its anterior and left side is formed by the fibres from the anterior or right surface, and in its posterior and in part of its right side by those from the left or posterior surface of the heart; it consists of a number of bent or convex fasciculi, which from this point radiate upwards and in a stellate manner in all lateral directions; when the serous membrane has been removed from this spot the interstices between these interlacing fasciculi can be expanded and stretched, the endocarde at the same time giving way, so that we can open into either cavity, without actually dividing any muscular fibre, because the deep layer of muscle does not descend quite to the point; hence another reason why the apex, especially of the left ventricle, is more liable to yield and to give way than any other portion of the parietes. The posterior superficial fibres ascend from the apex, partly in the septum, in the carneæ columnæ of the left ventricle, and in its posterior wall to the left auricular tendon; but very few of the superficial fibres cross the anterior vertical cardiac groove, from the right to the left ventricle, except near the apex; but several sink into the septum and intermingle with the ascending fibres, hence it is very difficult to unravel the septum in a satisfactory manner; on the posterior vertical groove a number of fibres pass across from the left to the right ventricle, and gradually bend into their course, while others pass into the septum; if the fibres crossing these two grooves be divided, we can, by patiently teazing through the septum with the handle of the knife, divide it into two laminæ, and thus separate the ventricles; we shall then be able to contrast the two, and to judge of the superior thickness and mass of the left, how it is pressed into the right, and how at the upper part, the infundibulum, or conus arteriosus of the latter, is bent over it like the beak of a bird. If the same operation have been successfully performed on the auricles, we shall then be able to separate the two perfect hearts, and again replace them, and thus accurately examine the relative position of the four openings in the circular auriculo-ventricular groove, also the position of the aortic root, behind and a little to the right side of that of the pulmonary artery, between the infundibulum and the right auriculo-ventricular foramen, and finally, the perfect crossing of these two great arteries. The deep muscular fibres of the ventricles are proper to each cavity; their direction is generally circular, though many are spiral, and some are oblique: they are placed between the descending and ascending portions of the superficial or common fibres; they are not, therefore, exposed to any extent, either externally or internally, without removing a portion of the latter, though inter-

nally they are in many places in contact with the endocarde; they encircle each cavity, the superior rings are the largest, are attached to the auricular tendons, and many of the middle bend spirally to attain the same attachment; the inferior rings diminish in size towards the apex, where they are very small and contracted; they do not extend to the very point, and through the last and smallest rings the superficial or common fibres ascend; each of these circular muscles is likened by Cruveilhier to a small oval barrel; the large end above, open into the auricle, the small end below, a little short of the apex, open also, but occupied by the ascending common fibres. The ventricular muscles differ from the auricular in being much more fleshy, red, and strong, also in the direction of the fibres; the superficial in the auricular being obliquely transverse, in the ventricular obliquely vertical, while the deep fibres in the former are circular round the transverse diameter of the cavities, and in the latter they are circular around their vertical axes. The action of the ventricular muscles must be to approximate the walls of the cavities they inclose, and as their fixed point is above at the fixed base of the heart, they must also shorten these chambers and urge their contents towards that point; and the mammillary muscles having disposed the auricular valves, so as to close the auricular openings, the blood is necessarily propelled into the two great arteries by the synchronous contraction of these muscles: the right ventricle, having to propel the blood through the pulmonary circulation only, requires less muscular energy and structure than the left, which has to influence the circulation through the entire system; and as both ventricles expel their contents superiorly, they require more muscular power in their centre and base than at the apex; for the effects of the systole must be, first to close this point, and then propel the blood from it to the centre and base of the cavity, and where, of course, a greater exertion is required to propel it into the arteries; this accounts for the thinness of the walls at the apex contrasted with the centre and base; the most fleshy part in the left ventricle is about its middle, and in the right nearer to its base.

The changes in the cavities of the heart, and the actions of the cardiac muscles during life, have been observed to occur in the following order: first, the two auricles become distended with blood from the six great veins as well as from the cardiac; this state (diastole) is followed by their rapid synchronous contraction or systole; this is accompanied by the enlargement, or diastole, of the two ventricles, and this is succeeded by their synchronous contraction, or systole, whereby the blood is propelled into the two great arteries; then a rest or pause ensues, during which the auricles are again gradually filled from the veins, and the same train of actions follows. The auricular diastole commences during the systole of the ventricles, and is completed during the pause or rest, in a longer or shorter time, according as the venous circulation is slow or rapid: the contractions of the auricles appear rather feeble, and are rapidly followed by the systole of the ventricles, or, as it is termed, the systole of the heart. The diastole of the ventricles presents two stages, the first occurs suddenly after their systole; in it the heart returns to its former state, as it were, of rest, and the apex retires backwards and downwards; the second stage is also rapid, and attended with a sudden and general expansion; the parietes feel smooth, soft, and flaccid; the first stage is owing, most probably, to the elasticity of the muscular tissue, the fibres of which must have been more or less under compression during the systole; the second stage depends on the systole of the auricles pouring in the blood, which, in the first stage, only flowed in a passive manner; many, however, incline to the opinion, that the diastole of the ventricles is not a mere passive, or elastic yielding, but a real, active dilatation, whereby the blood is drawn to fill the vacuum, as well as impelled by the contraction of the auricles. In the systole the surface of the ventricles is rugged

and firm, and the superficial veins distended; the cavities contract in every direction; the vertical and transverse axes are diminished, and the apex describes a spiral movement from right to left, and from behind forwards, so as to strike against the fifth and sixth ribs on the left side; the whole heart appears tilted a little forwards, but most probably the apex only is moved in this direction in any sensible manner. That the apex should thus advance to the wall of the thorax during the systole, that is, during the contraction and shortening of the ventricles, is contrary to what, from *a priori* reasoning, might be expected, and is, most probably, owing to the peculiar spiral arrangement of the muscular fibres, their greater length and quantity in front, their fixed attachment above to the auricular tendinous zones, their arched or looped course, and the terminations of several in the carneæ columnæ, in the septum, and in the parietes; this phenomenon, however, has also been attributed to other causes, namely, first, to the curvatures of the aorta and pulmonary artery; when the ventricles urge the blood into these arteries, it has been supposed that an effort is made to bring the heart and these curved tubes into one straight line; but the vessels being fixed, and the apex of the heart movable, it rotates upwards and forwards in an arc of a circle, and therefore approaches the ribs: secondly, to the position of the auricles, especially of the left, above and behind the ventricles; both auricles being distended at the moment of the ventricular systole, it has been maintained by some, must push forward the heart, and the apex in particular; and thirdly, this last agency has been supposed to be increased by the reflux of blood from the conical spaces inclosed between the tricuspid and mitral valves, meeting that which is flowing in from the large veins, and thus causing such a sudden distension of the auricles as may account for the protrusion of the heart; but none of these latter explanations will stand the test of minute examination, and we are therefore disposed to infer, that this change in position of the heart's apex rather depends on the arrangement of the muscular fibres as stated above.

The actions of the heart during life are accompanied by two distinct sounds audible with the stethoscope; the first is dull and prolonged; the second follows this rapidly, is sharp, clear, and quick, and is succeeded by a pause, after which the same sounds are again heard. The first sound is synchronous with the impulse of the heart against the ribs, or with the ventricular systole, and with the arterial pulse near the heart: the second sound is synchronous with the first stage of the ventricular diastole; the two sounds therefore correspond to one arterial pulsation. Various explanations have been offered, to account for these phenomena, such as the "*bruit musculaire*," attending the muscular contraction, particularly of the ventricles; the impulse of the latter against the chest in the first instance, and afterwards against the thoracic viscera; the propulsion of the blood through the auriculo-ventricular openings and the falling back of their valves; the rushing of the fluid over the internal rough surface of the ventricles; the sudden meeting of the auriculo-ventricular valves, by the action of the papillary muscles; the striking of the walls of the contracted ventricles against each other; the rushing of the blood towards and through the narrow arterial mouths, against the semilunar valves; and lastly, the arterial regurgitation of the blood against these valves when thrown across these openings. The limits of a work so purely practical as the present, do not permit the discussion of these hypotheses, many of them ingenious; I shall, therefore, only observe, that in all probability the first sound of the heart, which is heavy and prolonged, and synchronous with its systole, is owing partly to the "*bruit musculaire*" of the ventricular contraction, and to the impulse of the apex against the ribs, and partly to the flow of blood along the rough surface of the ventricles towards and through the narrow arterial openings, partly, also, to the rapid meeting of the auriculo-

ventricular valves and the equally sudden striking asunder of the semilunar valves; while the second sound, which is sharp and short, and synchronous with the first period of the ventricular diastole, depends upon the regurgitation of the arterial blood striking down the six semilunar valves during the recoil of the elastic coat of the arteries, and the diastole of the ventricles, which tends to draw back the blood towards themselves, by forming a vacuum beneath.

The frequency of the heart's action is very variable, being influenced by age, constitution or temperament, sex, mental emotions, state of health, form and capacity of the chest, rest, exercise, position of the body erect or horizontal, time of day, condition of other functions. In the fœtus *in utero* the pulsations are so rapid as 140 in one minute; after birth about 130, at the end of the third or fourth year about 100, at puberty 80, during middle age from 70 to 75, and in old age from 60 to 50; at this period, too, they are often very irregular, sometimes quicker, and frequently intermitting; exercise and digestion accelerate them; rest and sleep have the contrary effect; inspiration also quickens, but expiration retards the actions of the heart; in the former, however, they feel weaker than in the latter. In sthenic inflammations the heart's action is usually increased in frequency and force; but in the asthenic types it is often feeble, though frequent; indeed it is important to bear in mind, that frequency and force in many diseases, and in severe injuries of the nervous centres, or of important viscera, are often in the inverse ratio, the debility in the contractile power being compensated by increased frequency of action.

The heart is subject to many *diseases*, the morbid appearances of which will be soon detected by any person well acquainted with its natural structure. Carditis, or inflammation of its substance, is rare; it is usually confined to some portion of the organ, and pus is found diffused among its fleshy fibres, or sometimes collected into a cyst. Ramollissement; in this case the heart is sometimes so soft that the finger can pass through it; the color is brown, or deep red, if the change have been recent; if chronic, pale and yellowish; this affection sometimes ends in rupture. Induration is usually confined to some portions of the heart, which will be found so crisp as to grate under the knife. Hypertrophy, or enlargement of its cavities and thickening of its parietes; this change is most common in the left ventricle. Atrophy, or diminution of the organ; its fibres are pale, flabby, and intermingled with soft adeps; in this case the cavities are not diminished in size; this change is most frequent in the right ventricle. Tubercles are sometimes found in the parietes of the heart, and are very small. Sanguineous concretions, or coagula, incorrectly called polypi, are common in the right cavities, they are usually free from the color of the blood, and are like a mass of fibrine; in dropsical subjects they often appear gelatinous and semi-transparent; when recent they have no adhesion, but if long formed they often adhere closely. The aortic and mitral valves are often found diseased; on the latter fleshy vegetations frequently grow, and calcareous matter is very commonly deposited, both in these valves as well as in the semilunar folds at the aortic opening. The left auriculo-ventricular opening is occasionally so much contracted as to embarrass the circulation very considerably; this function is also occasionally suspended by a rupture of one of the mitral or semilunar valves. The valves at the right side of the heart are seldom found diseased. Malformation, or imperfect development, is not uncommon in this organ; thus the foramen ovale is sometimes open; also a communication between the ventricles, through their septum, occasionally exists. These conditions are usually attended with a bluish tint of the skin and other marks of imperfectly oxygenated blood.

CHAPTER IV.

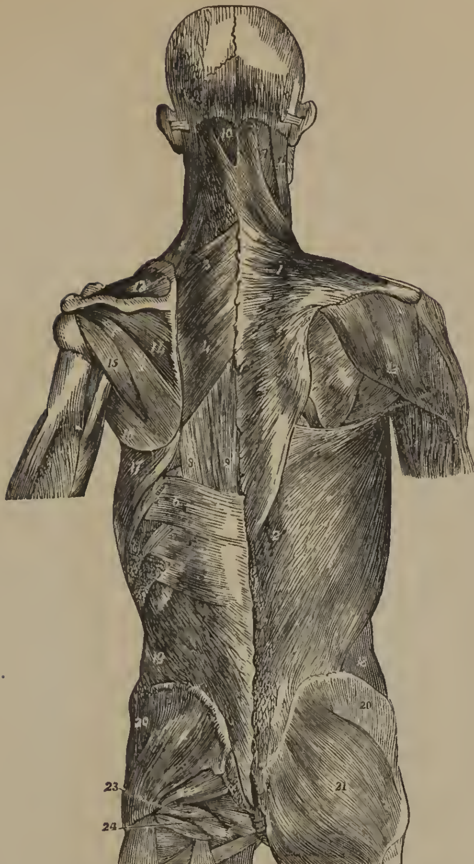
MUSCLES OF THE BACK.

SECTION I.

OF THE MUSCLES.

Place the subject on the forepart, raise the chest by blocks, and let the head and arms hang; thus the muscles in this region will be made tense. This region may be divided into three parts, the cervical, the dorsal or thoracic, and the lumbar or abdominal, conformably to the sections of the spinal column, but there is no exact limit to each, and most of the muscles extend through two or more of these divisions. Divide the integuments along the middle line, from the occiput to the sacrum; make a transverse incision from the last cervical vertebra to the acromion, and another from the last dorsal vertebra to the posterior part of the axilla; reflect the upper and lower flap of integument from the spine towards the side, and raise the middle portion from below upwards and inwards; thus the dissector can more easily expose the trapezius and latissimus dorsi muscles; the integuments in this region are dense, also the subjacent cellular tissue, which seldom contains much adeps; inferiorly it is often anasarcous; when all this is dissected from the posterior part of the trunk, we see exposed the trapezius superiorly, the latissimus dorsi inferiorly, and between these, in a small triangular space behind the base of the scapula, a part of the great rhomboid, also two or three tendons of the sacro-lumbalis, and a portion of the seventh, eighth, and ninth ribs, and of the corresponding intercostal muscles; along the middle line of the neck a strong ligament is observed (ligamentum nuchæ,) at the lower part of which is a strong aponeurosis of an oval form (the cervical aponeurosis;) also covering the lumbar region another still stronger is seen, (the lumbar fascia;) to each of these the student should pay attention. The *ligamentum nuchæ* is *inserted* superiorly into the occipital protuberance, it descends in the median line, broad above, sinks in deep, so as to form a septum between the muscles on the right and left sides, and is *inserted* by thin slips into the spinous processes of all the cervical vertebræ except the atlas, also into the first and second dorsal spines. *Use,* to support the head in flexion of the neck, and to give attachment to muscles. In man this ligament is composed of cellulo-ligamentous tissue, and is continuous with the supra-spinal ligament. In most quadrupeds it is very strong and elastic, and presents a good example of the yellow elastic tissue. The *cervical aponeurosis* is not an independent aponeurosis, but only an elliptical portion of the tendons of the trapezius on each side of the mesial line; it extends from the fifth cervical to the fifth dorsal vertebra, narrow at each extremity, and broad in the centre between the superior angles of the two scapulæ; the fibres are transverse, and continuous with the fibres of the trapezius on each side; it gives strength to these, and binds down the subjacent muscles. The *lumbar aponeurosis,* or *fascia,* is of great strength in the human subject; like the cervical it is not an independent structure, but a common tendon to several muscles, both of the back and of the abdomen; it is also somewhat oval, attached by its in-

Fig. 25.*



ferior extremity to the spinous processes of the sacrum, and by its superior to those of the inferior dorsal vertebræ and to the two last ribs; on either side it is connected to the crest of the ilium, and to the abdominal muscles, particularly to the transversalis, also to the latissimus dorsi and serratus posticus inferior; its internal surface is attached along the median line to the spines of the lumbar vertebræ, and on either side to the transverse processes. In the course of the dissection of the lumbar muscles, this fascia will be found to consist of three laminæ, the first, or posterior, that which is seen at present,

* The muscles on the posterior part of the trunk; on the left side the superficial layer has been removed. 1. The trapezius muscle. 2. The lattissimus dorsi muscle. 3. The rhomboideus minor. 4. The rhomboideus major. 5. The levator anguli scapulæ. 6. The serratus posticus inferior. 7. 7. The splenius muscle. 8. Portion of the sacro-lumbalis muscle. 9. Portion of the longissimus dorsi muscle. 10. Part of the complexus muscle. 11. Part of the sterno-mastoid. 12. The deltoid. 13. The supra-spinatus. 14. The infra spinatus. 15. The teres minor. 16. The teres major. 17. Part of the serratus magnus. 18. Posterior portion of the external oblique muscle. 19. Part of the internal oblique. 20. 20. The glutæus medius. 21. The glutæus maximus. 22. The pyriformis muscle. 23. The superior gemellus. 24. The inferior gemellus. 25. Portion of the obturator internus.

is very strong and deeply indented in the middle line, from being attached to the spines of the lower dorsal and to those of all the lumbar vertebræ and sacrum; it gives attachment to the latissimus dorsi, serratus posticus inferior, obliquus internus, and transversalis abdominis muscles. The second or middle layer is attached to the tips of the transverse processes of the lumbar vertebræ, and lies posterior to the quadratus lumborum muscle; and the third, or anterior layer, is in front of the quadratus and psoas muscles, and is attached to the roots of the transverse processes and to the sides of the bodies of the lumbar vertebræ. This fascia gives great support to the loins, where the skeleton is comparatively weak; like the ligamentum nuchæ it supports the trunk in flexion, it also assists in maintaining it *in equilibrio* in lateral motion, and it also serves to give attachment to several muscles, which again, in their turn, serve to keep it in a state of tension; this great tendinous expansion, together with that derived from the abdominal muscles in front, forms a sort of circular aponeurotic investment for this division of the trunk. The three laminæ of the lumbar fascia are regarded by many as the three tendinous layers of origin of the transversus abdominis muscle; the posterior layer (the true fascia lumborum) being the strongest, the anterior the weakest; the posterior and middle laminæ form one great aponeurotic sheath to inclose the erector muscles of the spine; while the middle and anterior form another, which incloses the quadratus lumborum muscle; the anterior lamina is also continued on the diaphragm, and forms the external ligamentum arcuatum; these points cannot be fully examined until the abdomen has been opened.

The muscles of the back are many of them indistinct, and vary very much in different subjects, both in their appearance and in their exact attachments to any certain number of vertebræ; the student is not to expect, therefore, to find each muscle in this region to correspond accurately with the description that is given, some being attached to a greater, others to a lesser number of processes than is stated. The muscles of the back are symmetrical on each side, and are arranged in *four* successive layers, each nearly covering the other between the integuments and the bones. These several laminæ differ in structure, form, and use; the first and second are broad fleshy expansions, the former rather triangular, the latter quadrangular, and (with the exception of the serrati) chiefly designed to move the shoulder in different directions. The third and fourth layers, not so distinctly separable, are principally elongated slips of muscular fibres, with numerous tendons, for the more convenient attachment to the projecting points of the vertebræ and of the occipital bone, for the purpose of securing the head upon the column, and of erecting and strengthening the latter, as well as for executing slight motions between its several segments, also for moving the head upon the atlas, and rotating both on the dentatus.

[FIRST LAYER—TWO PAIRS.

Trapezius,	*Vide page* 126.
Latissimus Dorsi,	" 127.]

TRAPEZIUS, broad, triangular, the base along the spine, the apex at the shoulder, thin above and below, thick in the centre; *arises* by a thin aponeurosis from the internal third of the superior transverse ridge of the occipital bone, from the ligamentum nuchæ, and from the spinous processes of the last cervical, and of all the dorsal vertebræ; the superior fibres descend obliquely outwards and forwards; the middle pass transversely; the inferior ascend obliquely outwards: all converge towards the shoulder, and are *inserted* into the posterior border of the external third of the clavicle, and of the acromion process, also into the upper edge of the spine of the scapula. *Use,* to raise and draw backwards the shoulder; the inferior fibres, which end in a trian-

gular-shaped tendon, which glides over the triangular smooth surface at the commencement of the spine, may draw down the base of the scapula, and thus, by rotating this bone, will elevate the acromion process, and assist the remainder of the muscle in raising the shoulder; the trapezius may also incline the head backwards and to one side. This muscle is only covered by the skin and a fine closely-adhering cellular tissue; its origin in many points is continuous with that of its fellow, and both are so thin and adherent to the integuments, that without caution in the dissection, they may be raised with the latter; it covers the splenii, complexi, serratus superior, levator scapulæ, supra-spinatus, a small portion of the infra-spinatus, and of the latissimus dorsi, also the rhomboid and deeper muscles; its anterior fibres are parallel to the sterno-mastoid, in contact with it above, but separated below, by fat, vessels, and nerves; in some subjects a band of fleshy fibres unites these muscles above the clavicle. The spinal accessory nerve is partly distributed to this muscle, whereby it is associated with the muscles of inspiration, which it can assist by raising and fixing the bones of the shoulders.

Latissimus Dorsi is very broad, and also triangular, the superior external angle being much elongated; it covers the greater part of the lumbar and dorsal regions, and extends from these to the inner side of the arm; *arises* from the six inferior dorsal spines, and by the lumber fascia from all the lumbar spines and supra-spinal ligament; also from the back of the sacrum, from the posterior third of the crest of the ilium, and by distinct fleshy slips from the three or four last ribs near their anterior extremity; the iliac and lumbar fibres ascend obliquely outwards; the dorsal, which are much weaker, pass transversely; and the costal are nearly vertical; all converge towards the inferior angle of the scapula, over which they glide, and from which they often derive an additional fasciculus of fleshy fibres; thence the muscle continues to ascend obliquely outwards over the teres major, and near the inside of the arm it twists beneath this muscle to its forepart, ends in a flat broad tendon, which is closely connected to that of the teres, and is *inserted* into the concave surface and into the inner or posterior edge of the bicipital groove, anterior and superior to that tendon; a small bursa is usually found between these tendons in this situation. *Use*, to depress the shoulder and arm, to draw the arm backwards and inwards, to rotate the humerus inwards, so as to turn the palm of the hand backwards, also to depress the ribs, as in expiration; but if the upper extremity be raised and fixed, this muscle may elevate the ribs, and so assist in inspiration, as well as in raising the whole body, as in climbing.

The dorsal portion of the latissimus dorsi is covered by the trapezius; the remainder of this muscle is superficial, its origin is superior to the glutæus maximus, its anterior edge is connected to the abdominal muscles, the inferior fasciculi of the external oblique indigitate with its costal origins; it covers the serratus inferior, the lumbar muscles, and the angle of the scapula; its humeral end forms the posterior fold of the axilla; a fasciculus of fleshy fibres sometimes passes across the floor of this region, and connects the latissimus to the great pectoral muscle; between the angle of the scapula and the humerus this muscle has a twisted appearance; the lumbar and costal fibres become anterior, and are inserted into the upper part of the tendon, while the superior or dorsal become posterior, and are inserted into its inferior edge; the axillary vessels and nerves lie on this tendon at its insertion, and the bicipital groove is lined by aponeurotic fibres derived from it, and from the tendon of the great pectoral, which are thus united to each other, although previous to this they are separated by the brachial vessels and nerves, and by the coraco-brachialis and biceps muscles; from the upper edge of the tendon a band ascends to the lesser tuberosity of the humerus, and from its lower border an expansion to join the brachial aponeurosis. D.

vide the trapezius and latissimus longitudinally between the spine and the scapula, reflect one portion towards the vertebræ, the other towards the side, and the second layer of the dorsal muscles will be exposed. In dissecting off the latissimus take care not to injure the serratus inferior, which is very thin and adheres closely to it.

[SECOND LAYER.—*seven pairs.*

Rhomboideus Major,	*Vide page* 128.
Rhomboideus Minor,	" " 128.
Levator Anguli Scapulæ,	" " 128.
Serratus Posticus Superior,	" " 129.
Serratus Posticus Inferior,	" " 129.
Splenius Capitis,	" " 129.
Splenius Colli,	" " 129.]

Fig. 26.*

RHOMBOIDEUS is the most superficial of this layer; broad, thin, thicker below than above; it is divided into a superior or minor portion, and an inferior or major; the *minor arises* from the lower part of the ligamentum nuchæ, and from the two last cervical spinous processes; the fibres run parallel outwards and a little downwards, and are *inserted* into the base of the scapula, opposite to and above the spine. The *major arises* from the four or five superior dorsal spines; the fibres pass outwards and downwards, parallel to the former, and are *inserted* into a thin tendinous arch which extends along the base of the scapula from its spine to the inferior angle, also into the latter by a strong tendon with which the arch is continuous; beneath the latter anastomosing vessels pass between the posterior and subscapular arteries. *Use*, to draw the shoulder backwards and upwards; the inferior fibres also can, by pulling back the inferior angle, rotate the scapula so as to depress the acromion process, thereby assisting the levator anguli and the pectoralis minor muscles. The rhomboid muscles are covered by the trapezius and latissimus, but a portion of the major between these muscles is subcutaneous; their origin is intimately connected with the trapezius, and their insertion is between those of the serratus magnus, and the supra and infra-spinati muscles; they conceal part of the splenii and serrati postici muscles.

LEVATOR ANGULI SCAPULÆ, long and flat, placed at the upper and posterior part of the side of the neck, *arises* by four or five distinct and separate tendons from the posterior tubercles of the transverse processes of the four or five superior cervical vertebræ; these soon terminate in a fleshy belly, which descends obliquely outwards and backwards, and is *inserted* into the base of the scapula, between the spine and superior angle; its *use* is to elevate the whole scapula, if assisted by the trapezius, or to elevate the superior angle alone, and to rotate the scapula so as to depress the acromion, thus co-

* A part of the second and third layers of muscles of the back. 1. The occipital bone. 2. The mastoid process of temporal bone. 3. The splenius. 4. The complexus. 5. The levator anguli scapulæ. 6. The serratus posticus superior. 7. The sacro-lumbalis. 8. The longissimus dorsi. 9. The spinalis dorsi. 10. Portion of the external intercostal muscles.

operating with the lesser pectoral muscle; it can also bend the head a little backwards, and to its own side. It is covered by the trapezius; a small portion may be seen superiorly between this and the sterno-mastoid muscle; the tendinous origins have those of the splenius colli behind them, and of the scaleni and rectus capitis anticus major before them. Divide and reflect the rhomboid muscles; beneath these a quantity of loose cellular membrane is placed, between them and the serratus magnus, to the posterior view of which muscle the student should now attend; he may, therefore, again peruse the account given of that muscle. (See page 82.)

Serratus Posticus Superior, placed on the superior posterior part of the thorax, somewhat square, *arises* by a thin aponeurosis from the ligamentum nuchæ, and from two or three dorsal spines, forms a thin fleshy belly, which ends in three fleshy slips, which are *inserted* into the upper borders of the second, third, and fourth ribs, external to their angles. *Use,* to expand the thorax by elevating the ribs and drawing them outwards. This muscle is covered by the trapezius and rhomboid; it lies on the splenius and the deep layer of muscles; an aponeurosis is continued from it to the inferior serratus.

Serratus Posticus Inferior, at the lower part of the dorsal, and upper part of the lumbar regions, is broader and thinner than the last, *arises* by a thin tendinous expansion, which is connected through the lumbar fascia to the two last dorsal and two upper lumbar spines; it forms a thin fleshy expansion, which divides into three or four fasciculi, which are *inserted* into the lower edges of the four inferior ribs anterior to their angles; the highest digitation is the largest, and the lowest extends as far forwards as the tip of the last rib. *Use,* by depressing the ribs it assists the abdominal muscles in *expiration;* also, by fixing the lower ribs, it increases the power of the diaphragm, and by aiding this muscle in enlarging the thorax it assists in *inspiration;* the two serrati also, by making tense the aponeurosis which connects them to each other, compress and support the deep muscles in this region. This *aponeurosis* may be named *vertebral* or *dorsal,* in contradistinction to the cervical and lumbar; is broad and quadrilateral, attached internally to the dorsal spines, externally to the angles of the ribs, below to the edge of the serratus inferior, and above to that of the serratus superior, beneath which also it extends to cover the splenii muscles; the fibres are mostly transverse; though thin, and nearly transparent, it is tense and strong. The serratus posticus lies under the middle of the latissimus dorsi, to whose tendon it adheres intimately, but can be separated from it by cautious dissection; its attachment to the ribs is behind those of the external oblique and latissimus dorsi muscles. Reflect from their origin the serrati; beneath the superior, we shall see the following muscle.

Splenius is long and fat, fleshy and tendinous, lying beneath the trapezius, and extending in an oblique direction from below, upwards, forwards, and outwards; it is divided about its centre into two portions, the inferior or splenius colli, and the superior or splenius capitis. The *splenius colli arises* from the spines of the third, fourth, fifth, and sixth dorsal, ascends obliquely outwards, and is *inserted* by distinct tendons into the transverse processes of the three or four superior cervical vertebræ behind the origins of the levator scapulæ. *Use,* to bend the neck backwards, and to one side. *Splenius capitis* is larger than the last, superior and internal to which it lies; it *arises* from the spinous processes of the two superior dorsal and three inferior cervical vertebræ, and from the ligamentum nuchæ; it ascends a little obliquely outwards, and, becoming larger, is *inserted* into the back part of the mastoid process, overlapped by the sterno-mastoid, also into the occipital bone, below its superior transverse ridge. *Use,* to bend back the head, and when one only acts to turn the head to that side; thus co-operating with the sterno-mastoid of the opposite side. The splenii are covered below by the rhom-

boids and serratus superior, higher up by the levator anguli scapulæ, and still higher by the sterno-mastoid muscles; strictly speaking, they are bu. one muscle. The splenii capitis muscles diverge superiorly, and the complexi, which converge, appear between them. Detach the splenii from the spinous processes, and divide the fascia lumborum, and the next layer of muscles will appear.

[THIRD LAYER.

Dorsal Group, three pairs.

Sacro-Lumbalis,	*Vide page* 130.
Longissimus Dorsi,	" " 130.
Spinalis Dorsi,	" " 131.

Cervical Group, four pairs.

Cervicalis Descendens, vel Ascendens,	*Vide page* 131.
Transversalis Colli,	" " 131.
Trachelo-Mastoideus,	" " 131.
Complexus,	" " 131.]

Fig. 27.*

Sacro-Lumbalis, Longissimus Dorsi, and Spinalis Dorsi; these three muscles are so closely connected inferiorly as to appear but one mass, of an oval form, narrow at the sacrum, full and prominent in the loins, and narrow in the back; several fibres must be divided in order to separate them from each other; they fill the hollow between the angles of the ribs and the spinous processes; the sacro-lumbalis is external, the longissimus dorsi in the middle, and the spinalis dorsi is internal. *Sacro-lumbalis* is the largest of the three; it *arises* from the posterior third of the crest of the ilium, from the oblique and transverse processes of the sacrum, from the sacro-iliac ligaments, and from the transverse and oblique processes of the lumbar vertebræ; it ascends and divides into several long tendons, which are *inserted* into all the ribs near their angles. *Use*, to extend the spine, and bend it a little to one side, also to depress the ribs as in expiration. The *longissimus dorsi* lies internal to the last, and *arises*, in common with it, from the posterior surface of the sacrum, and from the spinous, transverse, and oblique processes of the lumbar vertebræ; ascending along the vertebral column, it is *inserted* internally by small tendons into the transverse processes of all the dorsal vertebræ, and externally by fleshy and tendinous slips into all the ribs between their

* The deep seated muscles of the back, and posterior region of the neck. 1. 1. The mastoid process of the temporal bone. 2. A portion of the occipital bone. 3. 3. The ossa innominata. 4. The os coccygis. 5. The sacro-lumbalis muscle. 6. The longissimus dorsi.

tubercles and angles. *Use*, to extend, bend to one side, and support the spinal column. When we separate the sacro-lumbalis from the longissimus dorsi, and evert the former, we shall expose five or six small tendinous and fleshy fasciculi, which *arise* from the superior edge of each rib, and ascending are *inserted* into the tendons of the sacro-lumbalis; these are called the *musculi accessorii;* they are very irregular in number, structure, and size. *Spinalis dorsi* lies between the longissimus dorsi and spine; it *arises* from the two superior lumbar, and three inferior dorsal spines; it ascends close to the spinal column, and is *inserted* into the nine superior dorsal spines; its *use* is similar to the last. These three muscles are covered by, but distinct from, the lumbar fascia, and by the two preceding layers. These muscles in old subjects will be often found soft, weak, and pale, and often blended with a soft fatty substance, so as sometimes to resemble a mass of adipocere.

Cervicalis Descendens, or more properly Ascendens, looks like a continuation of the sacro-lumbalis, internal to which it *arises*, by four or five tendons, from as many of the superior ribs, between their tubercles and angles; these unite in a small fleshy belly, which ascends obliquely forwards and outwards, and is *inserted* by three or four tendons into the posterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ, between the splenius colli and levator scapulæ. *Use*, to extend the neck, and incline or turn it to one side; it may also assist in inspiration by elevating the ribs.

Transversalis Colli appears as a prolongation of the longissimus dorsi, internal to which it *arises* by shall tendinous and fleshy slips from the transverse processes of five or six superior dorsal vertebræ; the fibres uniting ascend obliquely outwards and forwards, and are *inserted* by small tendons into the transverse processes of four or five inferior cervical vertebræ, between the cervicalis descendens and the trachelo-mastoideus; its *use* is nearly similar to that of the last described muscle.

Trachelo-mastoideus, also like a continuation of the longissimus dorsi, lies internal to the last, and external to the complexus; it *arises* by several tendinous bands from the transverse processes of three or four superior dorsal vertebræ, and from as many inferior cervical; ascending a little outward, it is *inserted* into the inner and back part of the mastoid process, beneath the insertion of the splenius. *Use*, to assist in extending the neck, to bring the head backwards, and to incline and rotate it to one side. This muscle is covered by the splenius and transversalis; it lies upon the complexus, the obliqui capitis, and the digastric muscles.

Complexus, thick and strong, *arises* from the transverse and oblique processes of three or four inferior cervical, and five or six superior dorsal vertebræ, internal to the transversalis and trachelo-mastoideus; it forms a very thick muscle intersected by many tendinous bands; is ascends a little inwards, crossing the splenius, and is *inserted* close to its fellow into the occipital bone, between the two transverse ridges. *Use*, to draw back the head, to fix and support it on the spine, also to rotate it, being, in this action, an antagonist to the splenius, and an auxiliary to the sterno-mastoid of its own side. The complexus is concealed by the trapezius and splenius; its insertion, which is covered by the former only, can be felt and seen through the integuments; it lies on the semi-spinalis colli, the deep cervical artery, and the small obliqui and recti muscles; it is sometimes a digastric muscle, having a perfect tendinous intersection. Detach the complexus from the spine, and reflect it

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7. The spinalis dorsi. 8. 8. The cervicalis ascendens. 9. 9. The transversalis colli. 10. The trachelo-mastoideus. 11. The complexus. 12. 12. The semi-spinalis colli. 13. The semi-spinalis dorsi. 14. The rectus capitis posticus major. 15. The rectus capitis posticus minor. 16. The obliquus capitis inferior. 17. The obliquus capitis superior.

towards the occiput, and evert towards the ribs the other muscles of this layer; we shall thus expose the fourth layer of the dorsal muscles.

[FOURTH LAYER.

Dorsal Group.—six sets.

Cervical Group—four pairs.

SPINALIS, OR SEMI-SPINALIS COLLI, is one of the largest muscles in this region; it *arises* from the extremity of the transverse processes of five or six superior dorsal vertebræ, ascends obliquely inwards close to the spine, and is *inserted* by four heads into the spinous processes of the second, third, fourth, and fifth cervical vertebræ. *Use,* to extend the neck and incline it a little to its own side; this thick muscle fills up the space between the spinous and transverse processes of the cervical and dorsal vertebræ; it lies external to the semi-spinalis dorsi, is overlapped by the longissimus dorsi inferiorly, the complexus superiorly, and the serratus posticus superior in the middle.

SEMI-SPINALIS DORSI is similar to the last muscle in form and attachment; indeed they appear as one long muscle, which has been thus rather unnecessarily divided into two, each named from the situation of its principal portion; *arises* by five or six tendons from the transverse processes of the dorsal vertebræ, from the fifth to the eleventh; its fibres ascend obliquely inwards, and are *inserted* by five or six tendons into the spinous processes of two inferior cervical, and three or four superior dorsal vertebræ. *Use,* co-operates with the last-described muscle in extending the neck, supporting the trunk, and inclining the spine backwards, and to one side; it is situated close to the spine above, and internal to the last muscle; but below, it lies on the outer side of the spinalis dorsi.

MULTIFIDUS SPINÆ is close to the vertebræ, between the spinous and transverse processes, and is covered by the two last described muscles; it consists of a series of small tendinous and fleshy fasciculi; the *first arises* from the spine of the dentatus, or second vertebra, and, descending obliquely outwards, is *inserted* into the transverse process of the third; thus the succeeding muscles are attached, running obliquely from vertebra to vertebra between their spinous and transverse processes; some fasciculi extend over two or three vertebræ; the *last arises* from the spine of the last lumbar vertebra, and is *inserted* into the false transverse process of the sacrum. *Use,* to support the spinal column, extend it, and incline it to one side, also to rotate one bone upon the other, as far as their articulating surfaces will admit.

INTER-SPINALES are short muscles, consisting of longitudinal fibres; their name expresses their situation and attachment; between the cervical spines they are more distinct, and appear to be in pairs, right and left, as the spinous processes here are forked; some fibres in the neck deserve the name of *supra-spinous* muscles, as they pass over these processes, cover and adhere to several of them; in the back they are very indistinct, almost wanting, and in the loins they are much weaker than in the neck, chiefly consisting of ligamentous

fibres, with a few muscular intermixed. *Use,* to support and extend the spine.

Inter-Transversales consist of longitudinal fibres attached and situated as their name implies; between the cervical vertebræ these muscles are more strong and distinct, and consist of two planes, an anterior and posterior; between the lumbar vertebræ they are less distinct; and still less so, indeed often wanting, between the dorsal. *Use,* to support the spine on either side, and to bend it laterally. External to these in the back, the levatores costarum muscles are seen, which have been already noticed in the description of the intercostals. Between the occiput and the first and second vertebræ, the following four pair of muscles are situated:

Rectus Capitis Posticus Major, triangular; *arises* narrow from the spinous process of the second vertebra; ascends outwards, and is *inserted* broad into the inferior transverse ridge of the occipital bone. *Use,* to extend the head, or draw it backwards, so as to turn the face upwards, also to rotate it and the atlas on the dentatus, co-operating with the splenius of the same side; this muscle is situated obliquely between the occiput and the second vertebra; it is covered by the complexus; its insertion is overlapped by that of the superior oblique.

Rectus Capitis Posticus Minor, also triangular, *arises* narrow from the posterior part of the atlas; passes upwards, outwards, and backwards, and is *inserted* broad into the occipital bone, behind the foramen magnum. *Use,* to assist the former in drawing back the head, and steadying it on the spine; this pair is partly covered by the last muscles; a portion of them, however, is seen between these; both the recti resemble the continuation of the inter-spinous muscles, but are much more oblique, so that the name recti is by no means accurate.

Obliquus Capitis Inferior is the strongest of these small muscles; it *arises* inferior and external to the posterior rectus, and superior to the spinalis colli, from the spinous process of the second vertebra, ascends obliquely forwards and outwards, and is *inserted* into the extremity of the transverse process of the atlas. *Use,* to rotate the head and atlas on the second vertebra, co-operating with the splenius of the same side, and the sterno-mastoid of the opposite side; this muscle is covered by the complexus, trachelo-mastoideus, and trapezius it; conceals the lamina of the second vertebra, and the vertebral artery.

Obliquus Capitis Superior, smaller than the last, above the insertion of which it *arises,* narrow, from the upper part of the transverse process of the atlas, ascends obliquely inwards and backwards, overlapping the rectus, and is *inserted* broad into the occipital bone, between its transverse ridges, just behind the mastoid process, and above the rectus major. *Use,* to bend the head to one side, and to draw it a little backwards; it cannot have any rotatory power, as there is no rotation between the occipital condyles and the atlas. These four pair of muscles are but higher developments of segments of the long spinal muscles which have been traced inferiorly; the recti are analogous to the inter-spinous, the obliqui to the transverse spinous, for the mastoid process of the temporal, and the transverse ridge and tubercle of the occipital bones correspond to the projections of the spinal column. The recti and obliqui are separated from the complexi, by a strong aponeurosis, and much cellular tissue, which allows of the free motion of the atlas round the pivot of the second vertebra; these small muscles on each side bound a triangular space nearly equilateral; the recti in the middle line form the common base, the extremity of the transverse process of the atlas is the apex of each, while the superior and inferior oblique muscles form the sides; this space incloses a quantity of adeps and tough cellular tissue, deeply imbedded in which we may find the vertebral artery, a plexus of veins, some of which

join the vertebral veins, others pierce the atlanto-occipital ligament, or pass through the posterior condyloid holes to open into the lateral sinus; in this region also is the posterior division of the sub-occipital nerve, dividing into its branches to supply this group of small muscles; when all these parts have been removed, we shall expose the semicircular rim of the atlas, the lamina of the dentatus, and the posterior atlanto-occipital and axoid ligaments.

The muscles of the back are found very unequally developed in different subjects; in the young, active, and robust, who have died of acute disease, they will be found red, strong, and distinct; but in those who have been enfeebled and emaciated by long illness, in the paralytic, and the bedridden, also in the very old, especially of the female sex, they often present, particularly in the lumbar and dorsal regions, a pale, weak, soft, yellowish appearance, with but little remains of the true muscular structure, and are not unlike the degenerated fatty heart occasionally found in the old and anasarcous, or the muscles adjacent to a scrofulous joint. This abnormal condition, so often met with in the aged in these particular muscles, may be partly the effect of want of exercise, and appears in conformity with the general stiffening of the spinal column, and shrivelling of the inter-vertebral ligaments, whereas, the motions of the head and neck continuing to the latest period of life, the muscles in the cervical region preserve their normal structure.

In the dissection of the muscles of the back but few vessels or nerves of size or note are met with; the arteries which supply these muscles are branches of the occipital and deep cervical superiorly; the posterior branches of the intercostals in the middle, and of the lumbar arteries below. The veins accompany the arteries and join the nearest venous trunks. The nerves are the small posterior branches of the cervical, dorsal, and lumbar spinal nerves.

CHAPTER V.

DISSECTION OF THE UPPER EXTREMITY.

The upper extremity is connected to the trunk by the sterno-clavicular ligaments, and by ten muscles, of which one is connected to the clavicle (subclavius,) two to the humerus, (pectoralis major and latissimus dorsi,) and eight to the scapula, viz., trapezius, levator anguli scapulæ, omohyoid, rhomboid major and minor, serratus magnus, pectoralis minor, and latissimus dorsi; this last is also inserted into the humerus; all these muscles have been already examined; these the student may divide, then separate the extremity from the trunk, and place a block under the axilla; the dissection of the arm, however, may also be performed while it remains connected to the body. The muscles of the upper extremity are classed into those of the shoulder and arm, forearm, and hand.

SECTION I.

[The muscles which act upon the superior extremity, are arranged with express view to the two great functions of the extremity, of which the one is to prepare and carry food to the mouth, the other to defend the body, and particularly the head and face, from external violence, both of which actions

are prompted by the innate feeling of self preservation; accordingly, we find that those muscles which actually lie upon the extremity are so arranged, that all the extensor muscles are situated upon the outer and back part of the limb, while all the flexor muscles, are on the inner and forepart; which enables the extremity to be carried forward, inwards, and upwards, in a curvilinear direction so as to cover the face and thorax; this arrangement is very different from that of the inferior extremities, whose great function is progression and retrogression, (see muscles of lower extremity). The motions of the superior extremities are flexion, and extension, abduction, adduction, rotation, inwards and outwards, and circumduction; these motions are all performed by a rapid combination of actions, on the part of the flexor, and extensor muscles, except in the case of the revolution of the radius upon the ulna, for which purpose there are special and appropriate rotator muscles. The muscles which move the upper extremities, should be classed, as nearly as may be, according to their functions, and they may be examined in the five regions of the trunk, shoulder, arm, forearm, and hand; this arrangement has reference to the part upon which the muscles chiefly lie, and it will be seen, that those in the region of the trunk, are not what are usually considered as muscles of the extremity; in the several regions the muscles are arranged in classes having reference to the particular part of the extremity upon which they act, and lastly, the classes are divided into groups, according to the particular and principal motion effected by their contraction, as flexion, extension, &c.

In proceeding with the muscles which move the upper extremity, we first examine those on the region of the *trunk*, and we here find nine muscles on each side, all of which serve to connect the extremity with the trunk; these muscles are arranged in two classes, one of seven muscles, which act upon the shoulder, a second of two muscles, which act upon the os brachii.

FIRST CLASS, SEVEN MUSCLES.

Trapezius,	*Vide p.* 126.
Levator Anguli scapulæ,	" " 128.
Rhomboideus Minor, Rhomboideus Major,	" " 128.
Serratus Magnus Anticus,	" " 82.
Pectoralis Minor,	" " 82.
Subclavius,	" " 83.

Of these muscles the subclavius acts upon the clavicle only, the trapezius upon the clavicle and scapula, and the other five upon the scapula only; their combined action is to cause the scapula to rotate in such manner as to keep its glenoid cavity in contact with the head of the os brachii, so as to guard against dislocations of the shoulder joint. The omo-hyoid muscle is attached to the scapula but cannot affect its motions.

SECOND CLASS, TWO MUSCLES.

Pectoralis Major,	*Vide p.* 80.
Latissimus Dorsi,	" " 127.

These muscles act upon the os brachii to depress it, and are antagonists to most of the muscles on the region of the shoulder. The muscles of these two classes are situated on the anterior, lateral and posterior aspect of the trunk.

The muscles on the region of the *shoulder* are six in number on each side, constituting a single class, and arranged in two groups.

ONE CLASS, SIX MUSCLES.

First Group, five Muscles.

Deltoid,	*Vide p.* 140.
Supra Spinatus, } Infra Spinatus, }	" " 141.
Teres Minor,	" " 141.
Subscapularis,	" " 142.

These muscles all act upon the upper end of the os brachii, except the deltoid, and for the most part raise and abduct the arm, being antagonists to the pectoralis major, latissimus dorsi, and teres major.

Second Group, one Muscle.

Teres Major,	*Vide p.* 143.

This antagonizes the last group, and is a congener of the great pectoral and latissimus dorsi, with which last it is inserted: they depress and adduct the arm. The muscles of these two groups are situated for the most part on the surfaces and borders of the scapula.

The muscles on the region of the *arm* are five in number on each side, arranged in two classes; the first, of one muscle, acts upon the os brachii, the second, of four, acts upon the forearm, and is arranged in two groups of two muscles each.

FIRST CLASS, ONE MUSCLE.

Coraco-Brachialis,	*Vide p.* 143.

This muscle lies upon the inner aspect of the arm, which it raises, it is therefore a congener of the first group on the region of the shoulder.

SECOND CLASS, TWO GROUPS.

First Group, two Muscles.

Biceps Flexor Cubiti,	*Vide p.* 143.
Brachialis Anticus,	" " 144.

These muscles flex the fore arm upon the arm; the first can also act upon the arm.

Second Group, two Muscles.

Triceps Extensor Cubiti,	*Vide p.* 145.
Anconeus,	" " 157.

These muscles extend the forearm upon the arm, and the first can also act upon the arm. The muscles of the first group are on the fore and inner part of the arm, those of the second upon the back and outer part.

The muscles on the region of the *forearm* are nineteen in number on each side, arranged in three classes. The first, of four muscles, rotates the radius upon the ulna. The second, of six muscles, flexes and extends the hand upon the forearm; and the third, of nine muscles, flexes and extends the fingers upon the hand, and can also move the hand upon the forearm.

The first class has two groups of two muscles each, one for supination, the other for pronation. The second class has two groups of three muscles each, one for flexion, the other for extension. The third class has two groups, one of three muscles, which act upon the fingers generally, and is divided into two sets, another of six muscles, which act upon individual fingers, and is divided into three sets, according to the fingers to which they are attached.

FIRST CLASS, TWO GROUPS.

First Group, two Muscles.

Supinator Radii Longus,	*Vide p.* 155.
Supinator Radii Brevis,	" " 157.

Second Group, two Muscles.

Pronator Radii Teres, *Vide p.* 151.
Pronator Radii Quadratus, " " 154.

These four muscles are all on the anterior aspect of the forearm, and are all inserted into the radius; the two first turn the dorsum of the hand to the ground, and the two last the palm.

SECOND CLASS, TWO GROUPS.

First Group, three Muscles.

Flexor Carpi Radialis, *Vide p.* 151.
Flexor Carpi Ulnaris, " " 151.
Flexor Carpi Medius, or Palmaris Longus, " " 151.

Second Group, three Muscles.

Extensor Carpi Radialis Longus,
Extensor Carpi Radialis Brevis, } *Vide p.* 156.
Extensor Carpi Ulnaris,

The first group is on the forepart, and the second on the posterior aspect of the forearm.

THIRD CLASS, TWO GROUPS.

First Group, two sets.

First Set, two Muscles.

Flexor Digitorum Sublimis Perforatus, *Vide p.* 152.
Flexor Digitorum Profundus Perforans, " " 153.

Second Set, one Muscle.

Extensor Digitorum Communis, *Vide p.* 156.

These three are the common muscles of the fingers; the flexors are on the anterior, and the extensors on the posterior surface of the fore arm, hand, and fingers; their primary action is to flex or extend the fingers, their secondary action to flex or extend the hand.

Second Group, three Sets.

First Set, four Muscles.

Flexor Longus Pollicis, *Vide p.* 154.
Extensor Ossis Metacarpi Pollicis,
Extensor Primi Internodii Pollicis, } " " 158.
Extensor Secundi Internodii Pollicis,

These, as appears from their names, are all long muscles of the thumb; the first is on the anterior, the other three on the posterior and outer aspect of the forearm; these three will also abduct the hand.

Second Set, one Muscle.

Extensor Indicis, or Indicator, *Vide p.* 158.

Third Set, one Muscle.

Extensor Minimi Digiti, *Vide p.* 157.

These two are on the posterior face of the forearm, and can also assist in extending the hand.

The muscles on the region of the *hand* are twenty in number on each side, arranged in two classes; in the first class are the twelve common muscles of the hand, in two groups; in the second class are eight muscles belonging t. individual fingers, and arranged in three groups.

FIRST CLASS, TWO GROUPS.

First Group, one Muscle.

Palmaris Brevis,	*Vide p.* 150.

This is a superficial cutaneous muscle; it arches the palm.

Second Group, eleven Muscles.

Lumbricales, four,	*Vide p.* 154.
Interossei, seven,	" " 162.

These are deep-seated muscles; the lumbricales and four of the interossei are to be seen from the palm of the hand, the other three interossei from the dorsum.

SECOND CLASS, THREE GROUPS.

First Group, four Muscles of the Thumb.

Abductor Pollicis, Opponens Pollicis,	*Vide p.* 160.
Flexor Pollicis Brevis, Adductor Pollicis,	" " 160.

Second Group, one Muscle of the Fore Finger.

Abductor Indicis,	*Vide p.* 162.

Third Group, three Muscles of the Little Finger.

Abductor Minimi Digiti, Flexor Brevis Minimi Digiti, Adductor Minimi Digiti,	*Vide p.* 161.

If then, we review the muscles which act directly upon the superior extremity, we shall find that on the region of the trunk there are nine muscles; on the region of the shoulder, six; on the region of the arm, five; on the region of the forearm, nineteen; and on the region of the hand, twenty; in all, fifty-nine muscles for each extremity, or one hundred and eighteen for both; the same number will be found in the classification of the muscles acting upon the inferior extremities. Of the above number, it will be seen that one hundred muscles are situated upon the superior extremities themselves.

It may be proper to state here, that the muscles are subject to certain morbid conditions, of which one is preternatural contraction and rigidity; this is more fully referred to in the chapter on the muscles of the lower extremities. Inflammation of the muscles is less common than of some other tissues; it may be either acute or chronic; it seldom runs into suppuration, mortification, or ulceration. The muscles are sometimes in a softened, sometimes an indurated, and occasionally even an ossified state; this last affection is very rare, but a remarkable case is recorded in which most of the muscles of the extremities were converted into a solid mass of bone; the muscles of the shoulder, loins, and calf, are most subject to this change. The muscles sometimes undergo a fibrous or a fatty transformation; they may also be hypertrophied or atrophied; tubercular, melanotic, schirrous, and encephaloid deposit are very rare. These organs are sometimes infested by parasitic animals; many of the muscles are subject to congenital varieties, and those for the most part have their type in the muscles of different inferior animals.]

DISSECTION OF THE MUSCLES OF THE SHOULDER AND ARM.

Dissect off the integument from the shoulder and arm, as low as the bend of the elbow. The subcutaneous tissue is cellular and adipose, but very vari-

able as to quantity and consistence, and does not deserve the name of superficial fascia; beneath this, in the dissection of the scapula and brachial regions, we meet with different aponeuroses, which are more or less continuous with each other, but differ in structure in different situations.

1. The Supra-spinous Fascia; this is strong and tense, adheres to the borders of the fossa, and covers the muscle of that name, and is gradually lost on its tendon beneath the acromion process.

2. The Infra-spinous Fascia is also very strong, is attached to the borders of the corresponding fossa, binds down the muscle within, and sends in septa between it and the teres minor and major muscles; at the posterior edge of the deltoid it divides into two laminæ, one, thin and delicate, passes over this muscle and joins the brachial aponeurosis, the other continues on the infra-spinatus and teres minor tendons, passes loosely over the joint, and is lost on the biceps and coraco-brachialis muscles.

The Subscapular Fascia, weak and thin, but distinct, covers the muscle of that name, and divides it into fasciculi by septa which pass in deep to adhere to projecting ridges on the bone.

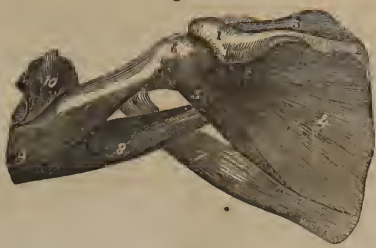
The Brachial Aponeurosis invests the arm down to the elbow, over which it is partially continued into the fascia of the forearm; it is weak and imperfect in some places, as on the deltoid muscle; in others, it is strong and well-marked; its strength and tension increase as it descends; its fibres are mostly in the circular direction, but many are spiral and vertical; above it is continuous with the fascia covering the pectoral and deltoid muscles, below the former it receives an addition from the fascia of the axilla, and from the posterior border of the latter, and from the infra-spinous fascia a considerable increase; still lower down, fibres join it from the insertions of the deltoid, pectoral, and latissimus dorsi; these last-named muscles are enabled thereby to act slightly on it, and increase its tension, as it has no distinct tensor muscle like the fascia of the thigh; about the middle of the arm the brachial aponeurosis adheres to the lateral ridges of the humerus by two septa named *internal* and *external intermuscular ligaments*, the fibres of these are oblique and vertical. The external commences at the lower part of the outer lip of the bicipital groove, receives a strong slip from the deltoid insertion, and descends to the outer condyle, is stronger and thicker above than below, it separates the triceps from the brachiæus anticus muscle, and both receive fibres from it; the musculo-spiral nerve and artery perforate it about its lower third, and then descend anterior to it. The internal is more distinct than the external, of a triangular form, the apex above thin, the base towards the inner condyle thick and strong; it commences from the inner lip of the bicipital groove, below the teres major tendon, soon becomes continuous with that of the coraco-brachial, crossing its fibres obliquely, adheres to the internal ridge of the humerus, and is inserted broad into the inner condyle; this ligament also separates the brachiæus and triceps muscles, and affords attachment to fibres of each; the ulnar nerve is anterior to it above, but perforates it, and lies behind it below; in addition to these two great septa between the flexors and extensors, this fascia also sends in thin processes to inclose the individual muscles, and to encircle the brachial vessels and nerves in an imperfect sheath; inferiorly it is prolonged into the fascia of the forearm, which we shall examine afterwards. The brachial fascia serves to confine the several muscles in their situations with such a degree of tension as not to restrain their actions; it also augments the surface of their attachment, and compresses them together so as to preserve the form and symmetry of the limb; it also protects the vessels and nerves.

Between the integuments and fascia of the arm we notice two cutaneous veins, the cephalic on the outer, and the basilic on the inner side; the *cephalic* will be found hereafter to commence about the thumb, and to ascend along

the radial side of the forearm, and having passed the elbow joint, it is now seen continuing its course up the arm, at first on the outer side of the biceps, and afterwards between the deltoid and great pectoral muscles to the clavicle, beneath which it sinks to join the axillary vein; the cephalic vein is unaccompanied by nerves in its course up the arm, but in the dissection of the forearm the external cutaneous nerve will be seen closely connected with it. The *basilic vein* will be found to commence about the little finger, to ascend along the ulnar side of the forearm, and to pass over the elbow joint; it is now seen continuing its course on the inner side of the biceps, between the skin and fascia, and about the middle of the arm it perforates the latter, to join one of the deep brachial veins; in some it continues superficial as high as the axilla, where it joins the axillary vein; the basilic vein in the arm is accompanied by the cutaneous nerves of Wrisberg, which having escaped the intercostal branches of the second and third dorsal nerves, and passed across the axilla, are then distributed to the integuments on the inner side of the arm; inferiorly the internal cutaneous branch of the brachial plexus accompanies this vein, and continues with it along the forearm: dissect off the fascia and cellular membrane from the muscles of the shoulder and arm.

Deltoides, very thick, strong, triangular, and bent so as to embrace the shoulder joint in front, externally and behind, *arises* tendinous from the lower edge of the spine of the scapula, and by fleshy fibres and tendinous plates, from the anterior edge of the acromion, and of the external third of the clavicle; the fibres converge and descend obliquely, the posterior forwards, the anterior backwards, and the middle at first outwards, and then vertically downwards; *inserted* tendinous into a rough surface, about two inches in extent, situated on the outer side of the humerus, and commencing just above its centre; this insertion will be found to be by three distinct tendons, the anterior and posterior of which are greater than the middle one; the pectoralis major is usually connected to the anterior. *Use*, to abduct and raise the arm; the anterior fibres can also draw it forwards, the posterior backwards, and when the arm is by the side, these portions can rotate it inwards or outwards. This muscle can also move the scapula on the arm when the latter is fixed, as in the case of a fall upon the hand or elbow, or in lifting a very heavy weight; under these circumstances this muscle sometimes co-operates with the great pectoral and latissimus dorsi, to dislocate the head of the humerus into the axilla. The deltoid is covered by the skin, a thin fascia, and a few fibres of the platisma; its origin corresponds to the insertion of the trapezius, with which it is often connected by aponeurotic fibres, so as to resemble a digastric muscle; its insertion is surrounded by the origin of the brachiæus anticus, and lies between the biceps and second head of the triceps; its posterior margin is thin, and is connected to the strong aponeurosis which covers the infra-spinatus muscle; its anterior edge is separated from the great pectoral, by the cephalic vein, some cellular membrane, and a small artery. This muscle is fleshy on its external surface, coarse and rough, and composed of several distinct triangular fasciculi, separated by fibro-cellular septa. Divide it transversely, and reflect each portion, and we shall then see that its structure is very complex, and that its internal surface is much more tendinous; an aponeurosis exists beneath it, which is attached above to the infra-spinatus fascia, and to the triangular ligament, and lost below on the biceps and coraco-brachialis muscle; a large *bursa* is also seen, which extends under the acromion, and is expanded on the tendon of the spinati muscles, and on the capsular ligament; it allows the deltoid muscle and the exterior of the shoulder joint to glide easily against each other. The deltoid also covers the coracoid process, the muscles which are attached to it, all the small muscles connected to the capsular ligament, the insertion of the great pectoral, and the circumflex vessels and nerves.

Fig. 28.*



SUPRA-SPINATUS fills the fossa of that name, and *arises* from all that portion of the scapula above its spine, which is engaged in forming this fossa, also from a strong fascia which covers the muscle; the fibres pass forwards beneath the acromion process and triangular ligament, end in a tendon which glides over the neck of the scapula (a bursa intervenes); *inserted* into the upper and forepart of the great tuberosity of the humerus, into the most anterior and superior of the three depressions which are marked on that surface. *Use*, to assist the deltoid in raising and abducting the arm; it also strengthens the capsular ligament, and draws it out of the angle which is formed by the elevation of the arm, between the humerus and the glenoid cavity; it also presses the head of the humerus and glenoid cavity towards each other, prevents the head of the former from descending out of the latter, and thus it becomes the antagonist to the pectoral, deltoid, and those other long muscles, which have a tendency to dislocate the head of the bone into the axilla; it also, on the other hand, prevents the head of the humerus being pushed upwards out of the glenoid cavity towards the acromion process; thus it affords greater security to the articulation than almost any other muscle in this region. This muscle is covered by the trapezius, much cellular membrane and fat, and by a strong aponeurosis; its insertion is concealed by the deltoid, and the large bursa beneath that muscle, also by the acromion process and triangular ligament; it covers the super-scapular nerve and vessels, and its tendon is inseparably connected to the capsular ligament.

INFRA-SPINATUS is inferior to the last, flat and triangular; *arises* fleshy from the inferior surface of the spine of the scapula, and from the dorsum of this bone, below this process, as low down as the posterior ridge on the inferior costa, but not from the rough surface on the inferior angle of the scapula; it also arises from the aponeurosis which covers it; the inferior fibres ascend obliquely forwards, the superior run horizontally; all converge, and are *inserted* by a strong tendon, which covers and adheres to the outer part of the capsular ligament, into the middle of the external or greater tuberosity of the humerus, below the supra-spinatus. *Use*, to assist the superior part of the deltoid in raising the arm, and drawing it backwards, also in rotating it outwards; when the arm has been raised, its lower fibres can depress it; it will also draw the capsular ligament out of the joint, and strengthen the articulation; it is covered by the trapezius and deltoid; but between these and the latissimus dorsi, a portion of it is superficial. It lies on the bone, and the scapular vessels and nerves; a large bursa lies between its tendon and the neck of the scapula.

TERES MINOR, small and narrow, inseparably attached to the last muscle, along the lower edge of which it runs; it *arises* from a depression between the two ridges on the inferior costa of the scapula, extending from the neck of the bone to within an inch and a half of its inferior angle, from the fascia which covers it, and from ligamentous septa which inclose it; the fibres as-

* The muscles of the shoulder, the superior portion of the deltoid has been removed. 1. The acromion process of the scapula. 2. The spine of the scapula. 3. The supra-spinatus muscle. 4. The infra-spinatus muscle. 5. The teres minor muscle. 6. The great tuberosity on the head of the humerus, into which the last three muscles are inserted. 7. The teres major muscle. 8. The long head of the triceps muscle. 9. The external head of the triceps. 10. The inferior portion of the deltoid muscle cut across.

cend obliquely forwards and outwards, cover and adhere to the capsule, and are *inserted* below the infra-spinatus into the inferior depression on the great tuberosity of the humerus, and into the bone a little lower down. *Use*, to co-operate with the last muscle. The origin of the teres minor is between and overlapped by the infra-spinatus and teres major muscles; its middle portion is superficial, and its insertion is covered by the deltoid; it lies on the scapula, sub-scapular vessels, capsular ligament, and long head of the triceps, which last separates it from the teres major; some fibres not unfrequently arise from the long tendon of the triceps itself.

Fig. 29.*

SUB-SCAPULARIS is situated on the inner side of the scapula, opposite to the three last-described muscles, broad and triangular, the base behind, the apex before; it *arises* from all the surface and circumference of the sub-scapular fossa, also by a few thick fibres from the long tendon of the triceps; the fibres run in thick fasciculi upwards and forwards, and all converge towards the neck of the scapula, over which they glide, in a sort of pulley, beneath the coracoid process, and the muscles which are inserted into it; they end in a tendon which is intimately united to the capsular ligament, and is *inserted* into the internal or small tubercle of the humerus; this muscle is covered by the scapula and the muscles of the shoulder; its inferior edge is in contact with the teres major; its internal surface, which forms part of the axilla, is connected to the serratus magnus, and the axillary vessels and nerves, by loose cellular membrane; a large bursa, very often communicating with the joint, lies between its tendon and the neck of the scapula, beneath the coracoid process; another smaller bursa is sometimes situated lower down, between the tendon and the capsular ligament; the inter-muscular septa often separate this muscle into three portions, which thus correspond to the three muscles on the other aspects of the joint. *Use*, this, which is the strongest of these *capsular* muscles, strengthens the inner side of the articulation, and guards against dislocation when the elbow is suddenly drawn backwards and outwards. This muscle can depress and adduct the arm, draw it backwards, and rotate it inwards, so as to turn the palm of the hand backwards; thus it antagonizes the infra-spinatus and teres minor muscles.

The deltoid and the four *capsular* muscles, which have been just described, are of great use to the shoulder articulation; the head of the humerus is so large, the glenoid cavity so superficial, and the capsular ligament so loose and long, that, but for these muscles, the bones could not remain in apposition; hence, in cases of paralysis of the muscles of this region, the joint becomes

* The subscapular muscle and muscles of the arm. 1. The coracoid process of the scapula. 2. The acromion process. 3. The superior costa of the scapula. 4. The supra-spinatus muscle. 5. The subscapular muscle. 6. The inferior border of the teres minor muscle. 7. The teres major muscle. 8. Portion of the latissimus dorsi muscle. 9. The coraco-brachialis muscle. 10. The short head of the triceps muscle. 11. The long head of the triceps. 12. The tendon of the biceps inserted into the tubercle of the radius. 13. The long portion of the triceps muscle. 14. Portion of the outer head of the triceps. 15. Internal or short portion of the triceps. 16. The brachialis anticus muscle. 17. Portion of the pectoralis major muscle.

elongated and flattened, and a partial dislocation exists; in the dissected limb also, if we divide all the muscles surrounding the capsule, and leave the latter uninjured, the bones will no longer be in contact; these muscles, therefore, serve to strengthen the capsule, to keep the head of the humerus pressed against the glenoid cavity, and thus to counteract that tendency to dislocate the head of the bone, which the larger muscles of the limb frequently have, in consequence of their insertion being at such a distance from the centre of the joint, added to the anatomical imperfections in the latter, already alluded to; which imperfections, however, are much counterbalanced by the great mobility which the joint enjoys in consequence of this formation, by the numerous opposing muscles which serve to protect the articulation, and by the rotatory motion of which the scapula is allowed to partake.

Teres Major, long and flat, *arises* from a rough, flat surface on the inferior angle of the scapula, below the infra-spinatus, and from the fascia, which separates it from the adjacent parts; it forms a thick fleshy belly, which ascends forwards and outwards to the inner side of the arm, and ends in a broad, thin tendon, which is at first closely connected to the back of the tendon of the latissimus dorsi; but near the humerus a small bursa intervenes, and is *inserted* into the inner or posterior edge of the bicipital groove, behind the tendon of the latissimus, and in general, but not always, extending lower down than it. *Use*, to rotate the humerus inwards, to adduct and draw it downwards and backwards; also to draw forward the inferior angle of the scapula; whereby it not only assists the capsular muscles in retaining these two bones in apposition, but it also keeps the glenoid cavity opposed to the head of the humerus. The origin of this muscle is superficial, but the latissimus dorsi generally overlaps it, and then, turning round its lower edge, becomes anterior to it; it is here connected to the infra-spinatus and teres minor; from the latter the long head of the triceps afterwards separates it; it passes anterior to this muscle, and assists the latissimus dorsi in forming the posterior fold of the axilla.

Coraco-Brachialis *arises* tendinous and fleshy from the point of the coracoid process, and from the tendon of the short head of the biceps; it descends obliquely forwards, and is *inserted*, chiefly tendinous, into the internal side of the humerus, a little below the middle, and into the ridge leading to the internal condyle, by an aponeurosis, which is connected to the internal inter-muscular ligament, and is thereby joined to the fascia of the arm. *Use*, to adduct, raise, and draw forwards the arm; also to rotate it outwards. The origin of this muscle cannot be separated from the short head of the biceps, but as it descends, it lies behind, and to the inner side of that muscle; it is covered above by the deltoid and pectoral; a small portion of it below is superficial, and is seen between the biceps and triceps; its insertion is just below that of the teres major, and separates the brachiæus anticus and posticus; the coraco-brachialis passes over the tendon of the subscapular, latissimus, and teres muscles; the brachial artery and median nerve at first lie to its inner side, but pass superficial to its insertion; the belly of this muscle is generally, but not always, perforated by the external, or musculo-cutaneous, or perforans Casserii nerve; one of the roots of the median nerve also sometimes passes through it.

Biceps is situated along the forepart of the humerus, and consists of two portions superiorly, the external or long, the internal or short; the *internal arises* tendinous from the coracoid process, between the coraco-brachialis and triangular ligament; it soon becomes fleshy, descends obliquely outwards, and a little above the middle of the humerus is united to the *external*, or *long* head, which *arises* by a long tendon, from the upper part of the glenoid ligament of the scapula; this tendon passes outwards through the joint over the head of the humerus, within the capsular ligament, but external to the

synovial membrane; it then descends into the groove, between the two tuberosities of this bone, in which groove it is bound down by tendinous fibres, continued from the capsular ligament, and from the adjacent tendons; the synovial membrane of the joint is reflected *on* this tendon at its origin, and is again reflected *from* it inferiorly on the parietes of the groove, between the tendons of the great pectoral, latissimus dorsi, and teres major muscles; thus, although the tendon passes through the cavity of the joint, it is, strictly speaking, external to the synovial membrane. About the middle of the humerus these two portions of the biceps unite in a large fleshy belly, which, descending to within about an inch and a half of the elbow joint, ends in a flat tendon; this sends off a process from its anterior and outer border, called the semilunar fascia, which passes obliquely inwards to join the general aponeurosis of the forearm, the tendon then sinks below the joint into a triangular hollow between the spinator longus and pronator teres, and is *inserted* into the back part of the tubercle of the radius; a bursa intervenes between this tendon and the anterior part of the tubercle, which is covered by cartilage; the *semilunar fascia*, which *arises* narrow from the forepart of this tendon, opposite the bend of the elbow, passes upwards and inwards, expanding towards the internal condyle, to which, and to the muscles proceeding from it, some of its fibres are attached; the remaining become continuous with the aponeurosis of the forearm. *Use*, to flex the forearm, and make tense its fascia; also to abduct and raise the arm. When the hand is prone, the first effect of the contraction of the biceps is to roll the radius outwards, and turn the hand supine, which it does with great power, as the tendon glides round the tubercle; the long tendon of the biceps, by passing over the head of the humerus, prevents this bone being dislocated upwards and outwards, as otherwise might occur, in consequence of a fall, or of a sudden muscular contraction; the biceps may also assist the coraco-brachialis, in rotating the scapula on the humerus, so as to depress the point of the shoulder. The long head of the biceps is concealed by the deltoid, supra-spinatus, and capsular ligament; the short head by the great pectoral and deltoid; not unfrequently this muscle has another origin from the humerus below its head; in some a fasciculus unites it to the coraco-brachialis, and in others to the brachiæus anticus muscle, which lies behind it. The belly is superficial, and lies on the brachialis anticus, so also is the tendon in its passage over the elbow joint; but as it approaches its insertion it lies very deep, and is embraced by the supinator brevis muscle, a bursa often separates it from the tendon of the brachiæus anticus; the brachial artery descends along its internal border, and somewhat overlapped by it, in the middle and lower part of the arm. This muscle or its tendon will serve as a guide in the living subject, in case we are required to tie this vessel, but superiorly the coraco-brachialis intervenes; the semilunar fascia is extended over the brachial artery and nerve, and affords them some, but not a constant protection, in performing venæsection in the median basilic vein, which vein is superficial to this fascia, but parallel, and often so close to the artery as to expose the latter to some danger in that operation. In dislocation, and in other injuries of the shoulder joint, the long tendon of the biceps is sometimes ruptured.

Brachialis Anticus, or Externus, improperly called by some Internus, *arises* from the centre of the humerus by two fleshy slips, one on either side of the insertion of the deltoid, from the forepart of the bone down to the condyles, and on each side as far as the intermuscular ligaments; the fibres descend converging, pass anterior to the elbow joint, adhere to the synovial membrane,, and are *inserted* by a strong tendon into the coronoid process of the ulna, and into a rough surface on this bone beneath that process. *Use*, to flex the forearm, and in doing so it draws the synovial membrane out of the angle of the joint; it also strengthens this articulation in its extended

Fig. 30.*

state, by pressing the ulna against the humerus, and supporting the joint in front; this muscle is covered by the biceps and by the brachial vessels and nerves; external to the biceps it is superficial; its external head is the longer, and lies between the deltoid and second head of the triceps; lower down the external cutaneous nerve and cephalic vein are to its outer border; and on a deeper plane, the musculo-spiral nerve and artery separate it from the supinator longus, and from the extensors of the carpus; the internal separates the deltoid from the coraco-brachialis; the tendon passes deep into the hollow at the elbow, behind the tendon of the biceps, and is inserted on its internal side; a fleshy fasciculus often unites this muscle and the biceps about the middle of the arm.

Triceps Extensor Cubiti covers the back of the humerus, and extends from the scapula to the olecranon; it consists superiorly of three portions, viz., the middle or long, the second or external, and the third or internal, or short head, or the brachiæus internus or posticus.

The *long* or *middle head*, *arises* by a flat short tendon, about an inch broad, from the lower part of the neck of the scapula, and from the anterior portion of the inferior costa; it also adheres to the inferior part of the capsule and to the glenoid ligament, somewhat like the biceps above, to which it is nearly opposite; it soon ends in a large fleshy belly, which descends along the back part of the humerus; that surface which is towards the bone continues tendinous for some distance; about the superior third of the arm it joins the *second* or *external head*, which *arises* immediately below the insertion of the teres minor by a narrow, tendinous, and fleshy slip, from a ridge on the outer side of the humerus commencing below the great tuberosity, and leading down to the external condyle, it also arises from the bone behind this ridge, from the intermuscular ligament, and from the external condyle, by a tendon which passes upwards and inwards, and joins the remainder of the muscle; these inferior fibres are parallel to the anconæus; the *third*, or *short head*, or *brachiæus internus*, or *posticus*, improperly called brachiæus externus, *arises* narrow on the inside of the humerus, above its centre, commencing tendinous just below the insertion of the teres major, and continuing to arise from the ridge which leads to the internal condyle, and from the internal intermuscular ligament; these three portions of the triceps unite above the middle of the arm, and, descending along its posterior part, end in a flat broad tendon, which consists of two laminæ, a superficial and a deep; the former is continued over the flat triangular surface of the olecranon into the fascia on the back part of the forearm; the latter, which is stronger but narrower, is *inserted* into the posterior border, but not the point, of the olecranon process. *Use*, to extend the forearm on the arm, and by its long portion to carry the arm backwards, and in some cases to adduct it; it also draws up the synovial membrane from between the olecranon process and the humerus, and

* A posterior view of the upper arm. 1. The posterior surface of the scapula. 2. The capsular ligament of the shoulder joint. 3. The long or middle head of the triceps muscle. 4. Its external head. 5. Its short or internal head. 6. Common tendon of the triceps muscle inserted into 7. The olecranon process of the ulna. 8. The internal condyle of the humerus.

thus protects it from pressure in the extended state of the limb. The long head gives support to the inferior part of the capsular ligament of the shoulder, and so tends to protect that joint against dislocation, in that situation where it would be most likely to occur. The sudden contraction of the triceps during life sometimes breaks off the olecranon process, and draws upwards the separated portion; of course, the individual loses for some time the power of extending the forearm; the fractured piece, however, is prevented being separated to any considerable distance, partly by a ligamentous band which extends from the coronoid process along its side, and partly by the aponeurosis of the triceps which covers the olecranon, and which joins the fascia of the forearm, also by the inferior fibres of this muscle, which, being connected to the condyles, and having to ascend a little to the olecranon, tend to keep down its fractured portion. The first, or long head of the triceps, arises and descends between the *two* teres muscles; the second, or outer head, commences below the teres minor; and the third, or the brachiæus internus or posticus, below the teres major; the long and the second head are covered above by the deltoid, the remainder of them is superficial; the second lies external to the supinator longus and radial extensors of the carpus; the third, or internal head, is also superficial, and lies between the brachialis anticus and coraco-brachialis anteriorly, and the long portion of the triceps posteriorly; the ulnar nerve descends along this, and the radial or spiral separates it from the second or outer head; a small bursa lies between the tendon and the point of the olecranon, a larger one between the skin and the aponeurosis which covers that process; this superficial bursa is peculiarly liable to inflammation, (which is generally of an unhealthy character,) in consequence of an injury, such as a fall upon the elbow, producing a superficial lacerated wound. In the dissection of the muscles of the arm, we should notice the course of the brachial artery and of its principal branches, also the divisions of the axillary plexus of nerves; the cutaneous veins have been already noticed; the deep veins accompany the arteries two to each.

The *brachial artery*, which is the continuation of the subclavian and axillary, descends obliquely outwards along the inner side, first of the coraco-brachialis, and afterwards of the biceps; near the elbow it inclines forwards, and then sinks beneath the fascia of the biceps, and a little below the bend of the elbow it divides into the radial and ulnar arteries. In this course it is covered by the fascia and integuments, and overlapped a little by the biceps; it is surrounded by a sheath of cellular membrane, which also contains the two venæ comites. The internal cutaneous nerve lies superficial to it; the median, or brachial, is also superficial to it above, and rather to its outer side; about the middle of the arm it crosses the artery, and inferiorly it is almost always to its ulnar or inner side. The ulnar nerve lies internal to the artery, and at some distance from it inferiorly; the radial or spiral nerve is posterior to it, and separates it above from the triceps. In this course the artery passes over the tendons of the latissimus and teres, a small part of the triceps, the coraco-brachialis, and the brachiæus anticus. The brachial artery gives off several muscular branches from its external side; and from its internal the superior profunda, which accompanies the spiral nerve round the back of the humerus to its external side; the inferior profunda which descends along with the ulnar nerve towards the inner condyle, and the anastomotica magna, which runs towards the inner side of the elbow joint.—See *Anatomy of the Vascular System.*

The branches of the brachial plexus of nerves, which are met with in the dissection of the arm, are six in number: first, the *internal cutaneous*, which has been already noticed; second, the *external cutaneous*, or musculo-cutaneous, or perforans Casserii, pierces the coraco-brachialis muscle, descends obliquely outwards between the biceps and brachialis anticus, to which it sends several filaments, and at the anterior edge of the spinator longus it be-

comes cutaneous, descending along with the cephalic vein and its branches; third, the *median*, or brachial nerve, accompanies the brachial artery to the bend of the elbow, and sinks beneath the muscles of the forearm, in the dissection of which the remainder of its course will be exposed; fourth, the *ulnar* nerve descends along the inner portion of the triceps, or the brachiæus internus, runs behind the inner condyle, and is then distributed to the muscles of the forearm and hand; fifth, the *musculo-spiral*, or radial nerve, descends between the second and third heads of the triceps, and winds round the back part of the humerus, supplying the triceps in its course; it next runs spirally forwards to the forepart of the bone, between the supinator longus and brachialus anticus; it then descends over the forepart of the elbow joint to the muscles of the forearm, where we shall trace it afterwards; sixth, the *circumflex*, or articular nerve, accompanied by the posterior circumflex artery, passes out of the axilla, between the long head of the triceps and the neck of the humerus, winds round the latter beneath the deltoid muscle, to which its branches are distributed.

The internal cutaneous is a simple nerve of sensation, all the others are compound; that is, they consist of motor and of sensitive filaments. The brachial, ulnar, and musculo-cutaneous, may be regarded as one large compound trunk, supplying sensitive branches to the anterior aspect of the forearm and to the hand generally, and to the fingers especially, and motor filaments to the flexor and pronator muscles; the musculo-spiral, with the circumflex, may also be considered as another great compound trunk, supplying chiefly the posterior and external aspect of the arm and forearm with sensitive, and all the extensor and supinator muscles with motor filaments, for the deltoid muscle may be regarded as an extensor of the limb. The first, then, might be named the great flexor, the second, the great extensor nerve of the upper extremity.—See *Anatomy of Nervous System.*

SECTION II.

DISSECTION OF THE FOREARM AND HAND.

Remove the integuments from the front and back of the forearm and hand, and the investing fascia will be exposed, together with the subcutaneous nerves and veins. The bursa between the skin and olecranon has been already noticed; small and imperfect bursæ will be found over each knuckle, also occasionally over the lower end of the ulna: the subcutaneous, cellular, and adipose tissue scarcely deserve the name of superficial fascia, they are variable in density and amount; there is more of the adipose on the front, the aspect of flexion, and more of the reticular posteriorly, or the aspect of extension. On the palm of the hand the integuments are thick and hard, and marked by many long indented lines, like the marks of folds crossing each other obliquely; on the forepart of the fingers are many fine striæ, placed transversely, or circularly, also longitudinally on the first and middle phalanges, and in regular, spiral, and numerous arched curves on the surface of the last; beneath these the cellular tissue contains a network of bloodvessels and nerves, the seat of the sense of touch: in the palm, the adipose substance is granulated and compact, and both it and the skin are connected by aponeurotic fibres to the subjacent strong palmar fascia; posteriorly the skin is fine, and the cellular tissue is loose and reticular, and contains a number of large superficial veins, which are arranged in a tortuous arch across the metacarpal bones, the convexity towards the fingers receiving the digital veins;

the superficial veins in the palm are very small, and most of them pass into the deep veins; from the extremities of the posterior cutaneous arch two principal branches proceed, the cephalic and basilic; the *basilic* commences by a small branch called salvatella, from the side of the little finger; it then ascends along the ulnar side of the forearm, receiving in this course small branches from the front and back of the arm, and passing anterior to the internal condyle, it is joined by the median basilic; it then ascends along the inner side of the arm, passes beneath the fascia, and joins one of the deep brachial veins; sometimes it continues in a superficial course to the axilla, and joins the axillary vein. The *cephalic vein* commences by several small branches about the thumb and back of the hand; it ascends along the radial side of the forearm, passes over the bend of the elbow, is joined by the median cephalic, and then ascends along the outside of the arm to the clavicle The *median vein* arises by small branches from the forepart of the wrist; it ascends along the forearm between the cephalic and basilic veins, and near the elbow divides into two or three branches: first, the *median basilic,* which ascends obliquely over the fascia of the biceps to join the basilic; second, the *median cephalic,* which passes obliquely upwards and outwards, and joins the cephalic vein; the third branch of the median, when present, sinks deep, and joins one of the deep veins: the cutaneous veins of the forearm are so variable as to size, number, and situation, that they seldom conform precisely to the description given by any author.—See *Venous System.*

Several subcutaneous nerves are met with in this dissection. The internal cutaneous nerve and its branches accompany the basilic vein, some passing anterior, others posterior to it, and are distributed to the anterior, internal, and posterior aspects of the limb. The external cutaneous, or musculo-cutaneous, in general lies behind the cephalic vein at the bend of the elbow; its branches afterwards twine around that vessel, and are lost on the anterior, external, and posterior parts of the forearm; the musculo-spiral nerve also gives off a cutaneous branch above the elbow, which descends on the outer and back part of the limb to the wrist; over the back of the thumb and hand ramify the dorsal branches of the radial and ulnar nerves, while the median and ulnar supply the forepart. The relation between the cutaneous nerves and veins is liable to great variety.

The fascia of the forearm, though semi-transparent, is very strong, particularly on the posterior part; it consists of tendinous fibres, which run in every direction, but principally in the circular and oblique, connected on either side to the condyles, and to the muscles which are attached to these; it receives an addition from the biceps before, and from the triceps behind; as it descends, it invests the limb so closely as to give it a certain form; it sends septa between the different muscles, which separate them into superficial and deep layers, and which also give attachment to several fibres; it adheres very closely to the olecranon and to the ulna its whole length; and inferiorly it is connected to the annular ligaments of the carpus. It is perforated by numerous holes for vessels and nerves; there is also a deficiency in it just above the fascia of the biceps, whereby the subcutaneous cellular tissue communicates with the inter-muscular; the fibres of this semilunar process from the biceps tendon descend obliquely towards the inner condyle, intersecting and uniting with the fibres of the aponeurosis which arises in this region; by means of this process the biceps muscle can act as tensor of the fascia of the forearm; it also bounds in front, and confines together the sides of the *anti-cubital fossa,* which is a sort of narrow, deep, triangular axilla, bounded internally by the pronator teres, externally by the supinator longus; the apex is below and external, the base is above and behind, formed by the brachiæus anticus covering the joint; into this hollow sink the median nerve, the brachial artery, with its venæ comites, and the tendon of the biceps a little

twisted, first giving off this fascia from its outer and anterior border. The *annular ligaments* of the wrist appear formed in part by this fascia, strengthened by proper transverse fibres. The *posterior* consists of transverse and oblique fibres attached internally to the lower end of the ulna, and to the back of the pisiform bone; externally to the lower end of the radius; it is divided into several channels, or canals, by fibrous septa, which pass forwards between the tendons and are inserted into the radius; there are six of these channels, and, tracing them from within outwards, are: first, for the extensor carpi ulnaris; second, the extensor minimi digiti; third, the extensor communis; fourth, the extensor pollicis major; fifth, the radial extensors of the carpus; and sixth, for the abductor, and extensor pollicis minor; all these sheaths are lined by distinct synovial bursæ, which accompany the tendons some way beyond the borders of the ligament, and which materially facilitate their motions. The *anterior* is much stronger and independent of the fascia, though connected to it; attached externally in a curved manner to the scaphoid and trapezium; the sheath of the flexor carpi radialis tendon runs through this insertion; internally, to the unciform and pisiform bones, also to the tendon of the flexor carpi ulnaris; the ulnar nerve separates these osseous attachments; the fibres are transverse and decussating, very strong, and almost as firm as cartilage; the fascia of the forearm is attached to it above, that of the palm below, the palmaris tendon in front, the origin of the short muscles of the thumb externally, and the palmaris brevis and muscles of the little finger internally; it forms with the forepart of the carpus a complete ring, through which pass the median nerve and nine tendons, viz.: the four deep and four superficial common flexors, also the long flexor of the thumb; the flexor radialis cannot be said to pass through it; the flexor ulnaris, and the ulnar nerve and artery, are anterior to it. This ring is lined by the great *carpal bursa*, which is reflected from the posterior surface of the ligament on the forepart of the common fasciculus of the nerve and tendons, then round their ulnar side to their back part, passing more or less between them, and thence to the front of the carpus, on which it extends considerably up and down, and prolonged for some way in the palm along the four flexor tendons. The flexor pollicis has a distinct synovial sheath which passes a considerable distance on this tendon in each direction. The carpal bursa is very liable to distension; it then bulges forward in an irregular form, above the ligament; it often contains a number of firm, small, granular bodies floating in a thin fluid; the uses of this bursa are obvious. On the back of the hand a very thin aponeurosis exists, continued from the posterior annular ligament; it consists of delicate transverse fibres which cover the extensor tendons; a loose elastic cellular tissue separates it from the integuments. Anteriorly, there is a remarkably strong fascia, the *palmar fascia:* this is of a triangular form, commences narrow at the annular ligament, from which, and from the tendon of the palmaris longus, it *arises;* it then expands over the palm of the hand, and near the fingers divides into four fasciculi, or rather into eight, as each of them is forked and *inserted* into either side of the sheaths of the flexor tendons, and into the capsular ligaments of the first phalanges; transverse bands pass across these diverging fasciculi, and prevent their divarication, and thus fibrous arches are formed under which the flexor tendons and the digital nerves and vessels pass, secure from displacement and from pressure; several fibres penetrate between the tendons, and join the metacarpal bones and the interosseous muscles; this fascia is closely connected to the integuments, but loose cellular tissue intervenes between it and the palmar vessels and nerves and the flexor tendons, which thus can move easily beneath it; two strong septa pass from its deep surface to join the interosseous fasciæ, and separate the middle of the palm from the external and internal lateral portions. The connections of the palmar aponeurosis to the sheaths of the

Fig. 31.*

tendons below, and to the annular ligament above, explain the effects of inflammation when seated within the former, such as the pain and tension in the palm, the fulness on the dorsum, and the extension of the disease to the forearm beneath the annular ligament. A thin aponeurosis, derived from the outer edge of the palmar fascia, covers the muscles of the thumb, and a similar one those of the little finger. Attached to the palmar fascia is the following small cutaneous muscle.

Palmaris Brevis *arises* from the annular ligament and from the inner edge of the palmar fascia; the fasciculi pass transversely inwards, and are *inserted* by scattered fibres into the integuments on the inner side of the palm of the hand. *Use*, to deepen the hollow of the palm of the hand by drawing the integuments towards the thumb; it covers the ulnar artery and nerve, and passes across the muscles of the little finger. We have no analogous muscle to this in the foot. We may now dissect off the fascia of the hand and forearm, to expose the muscles; in some situations it is difficult and indeed unnecessary to separate this from the muscular fibres; beneath the palmar fascia we expose the superficial palmar arch of vessels and nerves passing across the flexor tendons and the lumbricales muscles.

The muscles of the forearm are so very numerous, that it will be found convenient to class them according to their situations and their use. One set of these muscles is employed in bending the forearm, wrist and fingers: these are the *flexors:* a second, nearly allied to these, have the power of pronating the hand, that is, of rolling the radius across the ulna, so as to make the palm of the hand look downwards; these are the *pronators:* a third set, the *extensors,* can extend the forearm, hand, and fingers; and a fourth, allied to these, the *supinators,* can turn the hand supine; that is, place the radius and ulna on the same plane, and make the palm of the hand look upwards. The pronators and flexors arise chiefly from the internal condyle, and from the inner or ulnar side of the forearm; each of these divisions may be arranged into a superficial and deep layer.

The pronators and flexors, arising from the inner side of the forearm, are eight in number; five in the superficial layer, three in the deep; the five *superficial* are, the pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum sublimis, and flexor carpi ulnaris; the three *deep* muscles are the flexor digitorum profundus, flexor pollicis longus, and pronator quadratus. In the following description of these muscles, the hand is supposed to be

* The superficial muscles on the anterior aspect of the forearm. 1. The biceps muscle. 2. The inferior portion of the brachialis anticus muscle. 3. Inferior extremity of the external portion of the triceps. 4. The pronator teres muscle. 5. Portion of the supinator brevis muscle. 6. The flexor carpi radialis muscle. 7. The palmaris longus muscle 8 The insertion of the tendon of the palmaris longus into the palmar fascia and anterior annular ligament. 9. The palma fascia or aponeurosis. 10, 10. The anterior annular ligament. 11, 11. The flexor digitorum sublimis muscle. 12. The flexor carpi ulnaris muscle. 13. The pisiform bone. 14. The supinator radii longus muscle. 15. Portion of the flexor pollicis longus muscle. 16. The palmaris brevis muscle. 17. The tendon of the extensor ossis metacarpi pollicis. 18. Portion of the pronator quadratus muscle.

turned forwards, the radius externally, and the ulna internally; the elbow joint above, and the hand and fingers below; the words "internal" and "external," are used synonymously with "ulnar" and "radial;" and like the terms "abduction" and "adduction," are referred to the median line of the body; in the dissection, however, of some of the palmar and digital muscles, these latter terms have reference to the middle line of the hand, and not to that of the body. The muscles which arise from the internal condyle of the humerus are covered by the fascia of the biceps; they cannot be separated from each other above, but have a common tendinous origin from the condyle, the fascia, and its septa, also from the ulna.

Pronator Radii Teres *arises* tendinous and fleshy from the anterior part of the internal condyle, from the fascia of the forearm, and its intermuscular septa; also by a small tendon from the coronoid process of the ulna, which lies between the median nerve and the ulnar artery; the nerve separates these origins; the fibres pass obliquely outwards over the radius, and are *inserted*, chiefly tendinous, into the outer and back part of the radius, about its centre. *Use*, to pronate the hand, by rolling the radius forwards and inwards over the ulna; it is also a flexor of the forearm: this is the most external of the muscles arising from the inner condyle; it is superficial, except at its insertion, which is covered by the supinator longus, and by the radial vessels, and is inferior to the supinator brevis; this muscle forms the internal boundary of the triangular hollow at the bend of the elbow, which contains the tendon of the biceps, the brachial nerve and vessels.

Flexor Carpi Radialis *arises* narrow and tendinous from the inner condyle, and fleshy from the intermuscular septa; it forms a thick belly, which lies very superficial, and ends in a prominent flat tendon which is equally so; this descends obliquely outwards, passes beneath or through the annular ligament, and is *inserted* into the base of the metacarpal bone of the index finger. *Use*, to bend the hand, wrist, and forearm; it also assists in pronation; it may also abduct the hand. This muscle is overlapped above by the pronator teres, and covered below by the annular ligament and by the muscles of the thumb, so that its insertion cannot be seen until the palm of the hand has been dissected; it arises and descends at first between the pronator teres and palmaris longus, afterwards between this latter and the supinator longus, from which it is separated by the radial nerve and vessels: the radial edge of this tendon may serve as a guide in cutting down on the radial artery in the living subject.

Palmaris Longus *arises* by a slender tendon from the inner condyle, and from the fascia of the forearm; forms a short belly, which ends in a flat tendon; *inserted* near the root of the thumb into the annular ligament and palmar aponeurosis. *Use*, to bend the hand and make tense the palmar fascia; it descends between the flexor carpi radialis and ulnaris, and lies on the flexor sublimis, from which it is separated by a strong fascia. This muscle is sometimes wanting; occasionally it arises deep, in which case it is covered in the upper two-thirds of the forearm by the flexor sublimis.

Flexor Carpi Ulnaris *arises* tendinous from the internal condyle, tendinous and fleshy from the inner side of the olecranon process; the ulnar nerve and posterior ulnar recurrent arteries separate these origins; it also arises by a tendinous expansion from the inner edge of the ulna nearly its whole length, and from the fascia of the forearm; the fibres pass obliquely forwards to a tendon which descends in front of the ulna, and which overlaps the ulnar nerve and vessels, and is *inserted* into the pisiform bone, and by a few ligamentous fibres into the base of the fifth metacarpal bone; this insertion is also connected to the muscles of the little finger. *Use*, to flex the hand, and adduct it, particularly when assisted by the extensor carpi ulnaris; adduction of the hand is not so limited as abduction, in consequence of the ulna be-

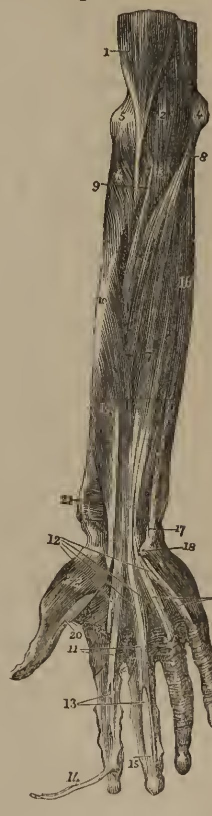
ing shorter below than the radius. This muscle is superficial, and lies internal and rather posterior to the preceding muscles; it descends between the flexor sublimis and extensor carpi ulnaris, and lies upon the flexor profundus; the tendon passes over the annular ligament, and is connected to it by a tendinous slip which also passes over the ulnar artery and nerve.

Flexor Digitorum Sublimis Perforatus, *arises* tendinous and fleshy from the internal condyle and internal lateral ligament; tendinous from the coronoid process, and fleshy from that portion of the radius which is below its tubercle, and internal to the pronator teres, and between the supinator brevis and flexor pollicis longus: it forms a large muscle, which ends in four tendons; these descend, two anterior, for the middle and ring finger; and two posterior, for the index and little finger; they all pass beneath the annular ligament, along with the median nerve, to their outer side; they occupy the inner half of this space, and are close to the unciform bone; they then proceed diverging along the palm of the hand, superficial to the deep flexor tendons, and beneath the palmar fascia; and at the first phalanx of each finger, or opposite the head of each metacarpal bone, each of these tendons becomes inclosed in a strong sheath, with one of the deep flexors, and is slightly concave over it; this sheath is continued to the anterior extremity of the second phalanx. Near the end of the first phalanx each of the superficial flexor tendons is split for the passage of the tendon of the deep flexor, which is continued on to the last or ungual phalanx; while the divisions of each of the superficial tendons become somewhat twisted, that is, the inner or opposed edges of the slit are everted or folded out beneath the deep flexor, so as to lie nearer to the bone and to the joint, connected together by cross slips, and are inserted by two processes into the anterior margins of the second phalanx about its centre. *Use*, to flex the second joint of each finger on the hand, the hand on the forearm, and the latter on the arm. The origin of this muscle is partly concealed by the three first described muscles, which arise from the inner condyle, and to which it is connected by the intermuscular septa; inferiorly a portion of it is superficial between the flexor carpi ulnaris and palmaris longus; above it covers the ulnar vessels and nerve, which separate it from the profundus; it also covers the median nerve and the flexor pollicis longus, to which it is often connected by a fleshy slip. The tendons are enveloped in the *carpal bursa* behind the annular ligament. In the palm of the hand they are covered by the integuments, palmar fascia, and the superficial palmar arch of vessels and nerves; above the metacarpo-phalangal joints, these, together with the deep tendons and the lumbricales, are bound down by the fibrous sheaths and arches formed by the septa of the palmar fascia, and immediately after, and through the rest of their course along the fingers each tendon is inclosed in a strong fibrous sheath, which is continued to the end of the second phalanx. The *sheaths* for the flexor tendons require special attention, they are covered by the integuments, and laterally by the digital vessels and nerves; one or two may be dissected; each of these sheaths is an osteo-fibrous canal or tube; the flat surface of the phalanges forming one wall, the remainder composed of strong semicircular fibres, interlaced, and of a pearly color, very dense opposite the phalanges, but thin, and even deficient over the angles of the articulations; they commence beyond the metacarpo-phalangal-joints, and are connected to their ligaments, and terminate above, between those of the second and last, or ungual phalanx, by intermingling with the deep flexor tendons; these tubes preserve their form even when the tendons have been removed; the fibres are arranged in semicircular fasciculi, and are attached to each border of the phalanges; open one of these sheaths, and the whole tube will be found lined by a synovial membrane, which is prolonged for some distance into the palmar region, and is reflected round these two tendons, inclosing each, and

forming two or three triangular folds or retinacula, one posteriorly near the base of the first phalanx, and extending from one tendon to the other; another more anterior, passes from the split in the superficial to the deep tendon; and the others pass from the deep tendon to the bone; these bursæ end in two cul de sacs, one in the palm, the other at the extremity of the second phalanx; the retinacula sometimes contain fibrous cords; they resemble the synovial folds in the knee joint, and may be designed partly to support the tendons, and partly to convey nutritious vessels to the different tissues. These sheaths are very useful in confining the tendons close to the phalanges, and preventing their starting forwards in the action of the muscles; the latter also, in consequence of their connection to the metacarpo-phalangal joints, are enabled to flex the first phalanges and the metacarpus, which possesses no distinct flexor, unless the flexor carpi radialis may be so considered.

Divide the flexor sublimis and carpi radialis, and the three deep muscles will be partially exposed, namely, the flexor digitorum profundus, flexor pollicis longus, and, nearly concealed by these, the pronator quadratus.

Fig. 32.*



Flexor Digitorum Profundus Perforans, *arises* fleshy from three superior fourths of the anterior surface of the ulna, and from the internal half of the interosseous ligament; it sometimes receives a small slip from the radius below its tubercle; it forms a thick muscle which descends along the middle and ulnar side of the forearm, between the flexor ulnaris and flexor pollicis, and ends in four flat tendons; these pass beneath the annular ligament, enter the ligamentous sheaths on the fingers, pass through the slits in the superficial flexor tendons, and are *inserted* into the last phalanx of each finger. *Use*, to bend the last phalanx, and to co-operate with the superficial flexor muscle in bending the other phalanges and the wrist; this muscle is covered by those of the superficial layer, which have been described; the ulnar vessels, the median and ulnar nerves, also descend along it; and it covers the ulna, the interosseous ligament and vessels, the pronator quadratus, and the carpus; beneath the annular ligament the tendons are placed behind those of the sublimis, and separated from them by folds of the carpal bursa; these deep tendons are not so distinct and separate as the superficial, but are united more or less by tendinous bands; that for the index finger, however, is usually distinct from the others, analogous in this respect to its extensor tendon; on each finger its tendon is superficial to that of the flexor sublimis after its transit through the slit; this portion of the tendon is marked by a longitudinal groove, and a retinaculum passes back from it to be inserted into the first phalanx. As the lumbricales muscles may be considered as accessory to

* The muscles on the anterior aspect of the forearm. part of the superficial layer having been removed. 1. The inferior extremity of the biceps muscle and its tendon. inserted into the tubercle of the radius. 2. The lower part of the brachialis anticus muscle. inserted into 3. The coronoid process of the ulna. 4. The internal condyle of the humerus 5. The external condyle of the humerus. 6. The supinator brevis muscle. 7. The flexor digitorum sublimis muscle. 8. Its attachment to the internal condyle of the humerus. 9. Its attach-

the deep flexor, they can be now examined, or their dissection may be postponed until that of the other palmar muscles.

LUMBRICALES are four in number, small, round, and fleshy, with long delicate tendons; they *arise* from the outer and radial side of the tendons of the flexor profundus, near the carpus, a little beyond the annular ligament; they each form a small fleshy belly, which ends in a tendon; this runs along the radial side of the finger, joins the tendon of the corresponding interosseous muscle, and is *inserted* about the middle of the first phalanx into the tendinous expansion which covers the back part of each finger. *Use,* to assist in bending the first joint of the finger; they cannot do so unless the flexors are tense; they can also adduct and abduct the fingers, and when the common extensor muscle is in action, they may assist in extending them; they may also prevent the displacement of the flexor and extensor tendons; these small muscles are covered by the superficial flexor tendons, palmar vessels and nerves; the first is the largest, the fourth the smallest; the two middle run nearly parallel, but the internal and external diverge; the tendons of the lumbricales frequently divide into two portions; one of these will be *inserted* into the first phalanx, the other into the posterior tendinous expansion.

FLEXOR POLLICIS LONGUS *arises* from the forepart of the radius, commencing narrow just below its tubercle, and from the interosseous membrane, to within about two inches of the carpus, it also very frequently arises by a long and narrow tendinous and fleshy slip from the coronoid process; this at first looks like a distinct muscle; all the fibres descend obliquely forwards to a tendon which passes beneath the annular ligament, close to the carpus, behind the median nerve, external to the deep flexor tendons, and surrounded by a distinct synovial membrane, it then runs outwards between the two portions of the short flexor, and the two sesamoid tubercles at the extremity of the metacarpal bone; it next enters a strong ligamentous sheath lined by a bursa, and is confined by it as far as the last phalanx of the thumb, into the middle of which it is *inserted.* *Use,* to flex and adduct the different joints of the thumb upon the hand, and the latter upon the forearm. This muscle is covered by the flexor sublimis and radialis, and by the radial vessels, and inferiorly by the annular ligament, it descends along the radial side of the flexor profundus.

PRONATOR QUADRATUS is exposed by separating the flexor pollicis and profundus; it is a small, square muscle, situated just above the carpus, and *arises* tendinous and fleshy from the inferior fifth of the internal and anterior surface of the ulna; the fibres pass transversely outwards, winding round the ulna, and descend a little to be *inserted* into the anterior part of the inferior fourth of the radius. *Use,* to roll the radius over the ulna, and so to pronate the hand; this muscle is covered by the tendons of the preceding, and by the ulnar and radial vessels, and it lies on the interosseous ligament, the radius, and the ulna.

The muscles which are situated on the outer and back part of the forearm are supinators and extensors, and are also arranged into two layers, a superficial and a deep; the superficial consist of seven, namely, supinator

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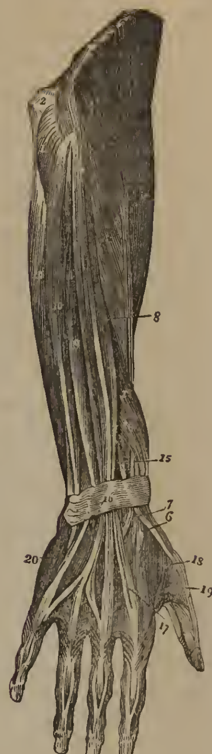
ment to the coronoid process of the ulna. 10. The attachment of the same muscle to the anterior surface of the radius. 11. The four tendons of the flexor digitorum sublimis. 12. The four tendons of the flexor digitorum profundus lying beneath the tendons of the superficial flexor. 13. 13. The split in the superficial tendons through which the tendons of the deep flexor pass. 14. The tendon of the deep flexor, divided and drawn downwards to show the disposition of the corresponding tendon of the superficial flexor. 15. A tendon of the deep flexor inserted into the last phalanx. 16. The flexor carpis ulnaris muscle. 17. The pisiform bone. 18. The hook of the unciform bone. 19. The flexor pollicis longus. 20. Its tendon passing between the two portions of the short flexor to the last phalax of the thumb. 21. The pronator quadratus muscle. 22. The abductor pollicis muscle.

radii longus, extensor carpi radialis longus, and brevis, extensor digitorum communis, extensor minimi digiti, extensor carpi ulnaris and anconæus; these muscles arise more distinctly than those on the internal side of the arm; some of them, however, particularly those on the back part, are closely connected to each other, arising in common from the external condyle of the humerus, from the posterior surface of the radius and ulna, also from the intermuscular ligaments and the fascia, which is partly derived from the tendon of the triceps.

Fig. 33.*



Supinator Radii Longus forms the prominence along the outer and anterior part of the forearm, *arises* tendinous and fleshy from the external ridge of the humerus, commencing a little below the deltoid, as high as the musculo-spiral groove, and continuing to within about two inches of the outer condyle; it also arises from the intermuscular ligament, which separates it from the second or outer head of the triceps, between which and the brachiæus anticus this muscle is situated. The supinator longus descends along the outer and anterior part of the elbow, and about the middle of the forearm ends in a flat tendon, which descends along the radius, and is *inserted* into a rough surface on the outside of that bone, near its styloid process, and sends off an expansion to line the groove for the extensor tendons of the thumb. *Use*, to roll the radius backwards, so as to make the hand look supine; it can also bend the elbow joint. When the forearm is extended and supinated, it is then a flexor of the elbow, but when the limb is pronated, it is then a powerful supinator; it can scarcely ever act as an extensor; it may have some influence as an abductor. This muscle is superficial; it passes over the extensor carpi radialis longus above, the tendon of the pronator teres in the middle, and the radius inferiorly; its tendon descends at first between the pronator teres and extensor radialis longus, afterwards between the latter and that of the flexor carpi radialis; at its insertion it is crossed by the extensor tendons of the thumb; the cephalic vein and external cutaneous nerve lie between it and the biceps; the musculo-spiral nerve and artery lie between it and the brachiæus anticus. This muscle and its tendon overlap the radial nerve and vessels; its ulnar edge, therefore, will serve as a guide to the latter, in case we are required, during life, to expose them, in order to tie a ligature around the radial artery.

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* The superficial layer of muscles on the posterior aspect of the forearm. 1. The external condyle of the humerus. 2. The olecranon process of the ulna. 3. The supinator radii longus muscle. 4. The extensor carpi radialis longus. 5. The extensor carpi radialis brevis. 6. The insertion of the tendon of the extensor carpi radialis longus into the second metacarpal bone. 7. The insertion of the tendon of the extensor carpi radialis brevis into the third metacarpal bone. 8. The extensor digitorum communis muscle. 9. The extensor minimi digiti. 10. The extensor carpi ulnaris. 11. The anconæus muscle. 12. Part of the flexor carpi ulnaris. 13. The extensor ossis metacarpi pollicis. 14. The extensor primi internodii pollicis. 15. The tendon of the extensor secundi internodii pollicis. 16. The posterior annular ligament of the carpus. 17. The tendon of the extensor indicis. 18. The first dorsal interosseous muscle. The other three dorsal interosseous muscles are seen between the metacarpal bones of the other fingers. 19. Part of the adductor pollicis. 20. The muscles of the little finger.

Extensor Carpi Radialis Longus *arises* tendinous and fleshy from the ridge on the external side of the humerus, between the supinator longus and the external condyle; it forms a thick, short belly, which passes over the outside of the joint, ends in a flat tendon, which descends along the outer and back part of the radius, runs through a groove on its lower extremity, and, passing over the wrist joint, is *inserted* into the back part of the carpal end of the metacarpal bone of the index finger, nearly opposite to that of the flexor carpi radialis. *Use:* it extends the wrist, bends the hand backwards, and abducts it a little; it may also assist in bending the elbow joint; its belly is covered by the last-described muscle, but projects behind it; the tendon descends behind that of the supinator longus, and passes beneath the extensors of the thumb and the annular ligament; it covers the supinator brevis and the following muscle.

Extensor Carpi Radialis Brevis *arises* tendinous and fleshy from the inferior and posterior part of the external condyle, and from the external lateral ligament, forms a thick belly, which descends along the back part of the radius, ends in a flat tendon, which runs through the same groove as the tendon of the last muscle, internal to which it lies: this groove is lined by a bursa, and is partly divided by a bony ridge; the tendon then passes beneath the annular ligament, and is *inserted* into the carpal extremity of the third metacarpal bone, or that of the middle finger. *Use,* similar to that of the last; it is covered superiorly by the last-described muscle, and by the supinator longus, and below by the tendons of the extensor muscles of the thumb, and by that of the last muscle, and by the skin; it covers the supinator brevis and the insertion of the pronator teres.

Extensor Digitorum Communis is situated more towards the back part of the forearm than the last-described muscles; it *arises,* in common with the last, and with the extensor minimi digiti, from the external condyle, the fascia, and its intermuscular processes, also from the ulna; it descends along the back of the forearm, and about the middle of the latter ends in four muscles, each of which ends in a tendon; these pass under the annular ligament in a groove in the radius, extend along the back of the hand, expanding as they approach the four fingers, into all the phalanges of which they are *inserted* by a tendinous expansion. *Use,* to extend all the joints of the fingers, also the carpus; this muscle arises between the extensor carpi radialis brevis and extensor minimi digiti; it descends superficially between these, and over the supinator brevis and extensors of the thumb; on the back of the hand the tendons are connected to each other by cross slips, but the tendon of the index finger is generally free; that which goes to the ring finger is the largest, and a strong transverse band often connects it to that of the little finger; all the tendons, as they approach the base of the first phalanx, become thick but narrow, and give off a fibrous expansion on each side to cover the joint; afterwards they enlarge and are joined by the tendons of the lumbricales and interossei; at the articulation of the first and second phalanx each divides into three bands; the middle one is inserted into the posterior surface of the upper end of the second phalanx; the lateral pass along the sides of this articulation; they afterwards converge and unite in a flat tendon, which is inserted into the base of the last or third phalanx. The back part of all the fingers is covered, so far as the last phalanx, by a tendinous expansion, derived from these tendons, and from those of the lumbricales and interossei muscles.

Extensor Carpi Ulnaris is very superficial, *arises* tendinous and fleshy between the extensor minimi digiti and anconæus, from the external condyle, fascia, and intermuscular septa; descends obliquely inwards, between the flexor ulnaris and extensor minimi digiti, towards the ulna, and receives an addition from it: it ends in a strong tendon, which runs through a groove on

Fig. 34.*

the back of the ulna, then beneath the annular ligament, and behind the cuneiform bone, and is *inserted* into the carpal end of the fifth metacarpal bone. *Use*, to extend the hand and bend it backwards; also to adduct it, that is, flex it laterally towards the ulna.

Anconæus, small, triangular, and placed at the outer side of the olecranon, beneath the skin; *arises* from the posterior and inferior part of the external condyle and lateral ligament by a very distinct tendon, also by some fleshy fibres from the lower border of the triceps, forms a thick triangular mass, which adheres to the synovial membrane, and descends obliquely inwards, to be *inserted* into the external surface of the olecranon, and about the superior fifth of the posterior surface of the ulna. *Use*, to extend the forearm on the arm, and to raise the synovial membrane out of the articulation; this muscle is partly covered by the tendon and aponeurosis of the triceps; the remainder of it is superficial; it is situated between the olecranon and the extensor carpi ulnaris; it often appears as a continuation of the triceps; it covers a portion of the radio-humeral joint, of the coronary ligament, and of the supinator brevis.

Extensor Minimi Digiti, *vel* Auricularis, *arises* in common with the extensor communis, and descends between it and the extensor carpi ulnaris; it forms a small fleshy belly, which descends very obliquely inwards, and ends in a slender tendon; this passes through a separate groove in the radius, and also through a distinct division of the annular ligament, in which situation it is frequently found divided into two, which continue in contact, and afterwards unite: this tendon becomes attached to the fourth tendon of the extensor communis, and is *inserted* along with it into the posterior part of the phalanges of the little finger. *Use*, to assist the extensor communis, and to extend and abduct the little finger independent of the others.

The deep muscles in this situation are five in number, they will be exposed by removing the superficial layer; they consist of the supinator radii brevis, three extensors of the thumb, and the indicator.

Supinator Radii Brevis, short and flat, surrounds the upper part of the radius, *arises* from the external condyle, external lateral, and coronary ligaments, and from a ridge on the outer side of the ulna, which commences below its lesser sigmoid cavity; the fibres adhere to the capsular ligament, and descend obliquely outwards and forwards round the upper part of the radius, and are *inserted* into the upper third of the external and anterior surface of this bone, from above its tubercle down to the insertion of the pronator teres. *Use*, to turn the radius outwards, so as to make the hand look supine, which it can effect with great power; it can also assist in extending the forearm. This muscle nearly surrounds the upper part of the radius, it is covered by

* The deep layer of muscles on the posterior aspect of the forearm. 1. The external condyle of the humerus. 2. The olecranon process of the ulna. 3. The supinator radii longus. 4. The extensor carpi radialis longus. 5. The extensor carpi radialis brevis. 6. The aconæus. 7. The supinator radii brevis. 8. The posterior surface of the radius. 9. The posterior surface of the ulna. 10. Portion of the flexor carpi ulnaris. 11. Extensor ossis metacarpi pollicis or abductor pollicis longus. 12. The insertion of its tendon into the metacarpal bone of the thumb. 13. The extensor primi internodii pollicis. 14. The extensor secundi internodii pollicis. 15. The extensor indicis. 16. The inferior portion of the tendon of the extensor carpi ulnaris.

the supinator longus, the radial extensors of the carpus, and the extensor digitorum communis externally; by the anconæus and extensor ulnaris posteriorly; and anteriorly by the radial nerve and vessels, and by the brachiæus and biceps; it partly surrounds the humeral and ulnar articulations of the radius; its anterior edge is notched above for the insertion of the biceps, and is overlapped by the pronator teres below; it is perforated by the posterior interosseous nerve.

Extensor Ossis Metacarpi Pollicis, or Abductor Pollicis Longus, *arises* fleshy from the middle of the posterior part of the ulna, below the anconæus, also from the interosseous ligament and posterior surface of the radius below the supinator brevis; it descends outwards and forwards, and ends in a tendon, which passes through a groove on the outside of the lower end of the radius, runs by the side of the carpus, and is *inserted* in general by two tendons, one into the os trapezium, and the other into the upper and back part of the metacarpal bone of the thumb. *Use*, to extend the first joint of the thumb, and separate it from the fingers; it also extends the wrist, and abducts the hand; it can also assist in supination. The origin of this muscle is concealed by the extensor communis and carpi ulnaris; the tendon is superficial, and passes over the tendons of the radial extensors of the carpus, also over the radial vessels. I have sometimes found a second muscle analogous to this, but arising so high as from the external condyle of the humerus, and ending in a very long slender tendon which accompanied that of the last muscle, and inserted along with it into the metacarpal bone of the thumb.

Extensor Primi Internodii Pollicis, or Extensor Minor, *arises* from the back part of the ulna, below its middle, and from the interosseous ligament and radius; it descends along the ulnar side of the last muscle; its tendon passes through the same groove in the radius, and bound down by the same portion of the annular ligament, and is *inserted* into the posterior part of the first phalanx; a small slip is often continued on to the second phalanx. *Use*, to extend the second joint of the thumb, and to assist the last-described muscle; its connections are also similar.

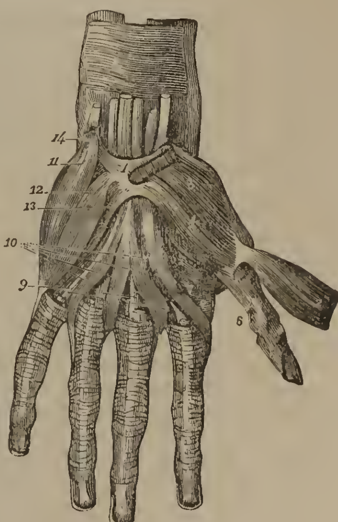
Extensor Secundi Internodii Pollicis, or Extensor Major, *arises* from the posterior surface of the ulna above its centre, and from the interosseous membrane; its belly overlaps the two former muscles, its tendon passes along a distinct groove in the radius, runs over the outer side of the wrist, the metacarpal bone, and first phalanx of the thumb, and is *inserted* into the posterior part of the second or last phalanx. *Use*, to extend the last phalanx of the thumb upon the first, and to assist the former muscles in extending and supinating the hand. The tendon of this muscle is separated from the two former, on the outer and back part of the wrist, by a small space distinct through the skin, in which we perceive the tendons of the radial extensors of the carpus, and the radial artery; the relations of this muscle in other respects are nearly similar to those of the other extensors of the thumb.

Extensor Indicis, or Indicator, *arises* from the middle of the posterior surface of the ulna and interosseous membrane; its tendon passes under the annular ligament along with those of the common extensor, is attached to the radial side of that tendon which belongs to the forefinger, and is *inserted* along with it into its second and third phalanges. *Use*, it assists the common extensor, or produces the extension of the forefinger alone, as in pointing. This muscle is concealed by the extensor communis and ulnaris, lies to the ulnar side of the extensor pollicis major, and its tendon passes under those of the common extensor, to which it is sometimes connected by a tendinous slip. Next dissect the muscles of the hand, which consist, externally, of the muscles of the thumb; internally, of those of the little finger, and in the middle of

the lumbricales superficially, and the interossei, deep-seated; the lumbricales, or the accessories to the flexor profundus, have been already examined.

In conducting the dissection of this region, the student should make frequent and careful reference to its skeleton: we may observe that few portions of the animal frame present more interesting characters for minute anatomical examination than the human hand, as it, most probably, affords the best example that could be adduced, not only of superiority in the human organization, when contrasted with that of any other created being, but also of the most perfect adaptation of structure to function, of means to an end, of design in a plan, and of perfection in its execution. The great number of small bones, twenty-seven in all, with their joints and ligaments so securely connected, and so neatly adapted, as to combine the opposite qualities of strength and freedom of motion, all collected into so small a space, with the numerous long and slender tendons, elegantly shaped, and each confined in its appropriate highly polished sheath or groove; the muscles of these, some large and strong, others small and weak, all linked together in the closest sympathy, and endowed with powers of executing the most varied motions, delicate, yet rapid, powerful, yet enduring, often instinctive, and, as it were, without our thought or cognizance; yet are all these muscles voluntary and wonderfully capable of education and improvement, so as to become, not only the principal agents in most of the physical acts of life, defensive or offensive, but also the immediate instrument in the production of every work of art, thereby, in a great measure portraying the feelings of the mind, and the powers of the intellect. The large supply of bloodvessels and of nerves, imparting the highest sensibility, and the most exquisite delicacy of tact and feeling, and these properties, too, residing in a part necessarily, and almost constantly exposed to violence or injury; these, and many other circumstances connected with the organization and the functions of the hand, are eminently calculated to excite our curiosity, and, when fully and properly investigated, cannot fail to insure admiration and respect.

Fig. 35.*



The eight bones of the carpus, small, and of irregular forms, are compacted into an arch, which, by means of the annular ligament, is converted into a ring; thus this weak pile of bones acquires much strength, and a secure passage is provided for the tendons, vessels, and nerves. The nineteen metacarpal and phalangal bones, by their great length, add considerably to the length of the hand, and extend the sphere of its motions. The metacarpus is arched towards the palm in both

* The muscles of the hand. 1. The anterior annular ligament. 2. The abductor pollicis muscle divided close to its attachment to the annular ligament and thrown downwards. 3. The flexor ossis metacarpi, or opponens pollicis. 4. The anterior, or external portion of the flexor pollicis brevis. 5. The posterior, or internal portion of the same muscle. 6. The tendon of the flexor pollicis longus. 7. The adductor pollicis. 8. Portion of the first dorsal interosseous muscle. 9. Tendons of the flexor digitorum profundis. 10. The four lumbricales muscles. 11. The abductor minimi digiti. 12. The flexor brevis minimi digiti. 13. The opponens or adductor minimi digiti. 14. The os pisiforme.

directions, thereby imparting that degree of strength which it requires as a medium for supporting the weight of the body, as is occasionally required, and at the same time fitting it the better to serve as an organ of prehension; this cup-like form of the palm is beautifully completed by the muscular ball of the thumb externally, and by the muscles of the little finger internally: the very limited motions of the metacarpus on the carpus secure this form permanently, while the arthrodial metacarpo-phalangal joints admit of motion in all directions, and the gynglymoid phalangal articulations allow of no motion laterally or backwards beyond the line of extension, but can be flexed to a right angle, thus serving either to close the hand completely, or to be used as instruments of touch with firmness and precision; the last phalanx is peculiarly shaped and flattened, so as to support the nail behind, and the pulpy organized apparatus for the sense of touch in front.

The short muscles of the thumb are four in number, viz., the abductor, opponens, flexor brevis, and adductor pollicis.

Abductor Pollicis *arises* broad and thin from the anterior part of the annular ligament, os naviculare, and trapezium, and from the tendon of the abductor longus, *inserted* into the outside of the base of the first phalanx, and by an expansion into the back of both phalanges; its name implies its *use*, to separate the thumb from the fingers; it lies superficial, and is most external of these small muscles, which form the ball of the thumb.

Opponens Pollicis, or Flexor Ossis Metacarpi, *arises* from the annular ligament and os naviculare; *inserted* into the anterior extremity of the metacarpal bone of the thumb. *Use*, to approximate the thumb to the fingers; it is internal to and partly overlapped by the last muscle; it lies on a part of the annular ligament, and of the following muscle, from which it is separated with difficulty.

Flexor Pollicis Brevis, consists of two portions, between which is the tendon of the flexor longus; one head, the *external* or *anterior*, *arises* from the inside of the annular ligament, and from the trapezium and scaphoid bones, passes outwards, and is *inserted* into the external sesamoid bone, or cartilage, and base of the first phalanx of the thumb; the second, or *internal* or *posterior*, *arises* from the os magnum, from the base of the metacarpal bone of the middle finger, and from the sheath of the flexor carpi radialis; it also passes outwards, distinct from the other at first, but afterwards united to it, and *inserted* into the internal sesamoid bone, and base of the first phalanx. *Use*, to flex the first phalanx and metacarpal bone on the carpus; this muscle is concealed by the two former, and by the first lumbricalis; it covers the two first interossei muscles, and the tendon of the flexor carpi radialis; its outer edge is connected to the opponens pollicis, and the internal to the adductor.

Adductor Pollicis, triangular and broad, *arises* fleshy from three-fourths of the anterior surface of the third metacarpal bone, or that of the middle finger; the fibres pass outwards over the second metacarpal bone, and converging are *inserted* into the inner side of the root of the first phalanx of the thumb, along with part of the last muscle; its name denotes its *use*. This muscle at its origin is covered anteriorly by the deep flexor tendons and by the lumbricales; its insertion is covered by the abductor indicis. The adductor pollicis may be regarded as the first of the anterior interossei; it is, however, much stronger than any of that group, and differs from them in passing over one metacarpal bone between its origin and insertion; this is for the purpose of increasing the extent of adduction of the thumb. The number and strength of the muscles of this finger, as well as the peculiarity of its carpal articulation, render it eminently useful, and altogether superior to the corresponding member in any other animal, even in the highest of the quadrumana; it possesses two flexors, three extensors, one of which is a powerful abductor, also a short abductor, an opponens, and a very strong

adductor; the alternate, combined, or varied actions of these muscles can move the thumb in all directions.

On the inner side of the palm of the hand are the short muscles of the little finger, which are three in number; also the cutaneous muscle, palmaris brevis, which has been already examined.

Abductor Minimi Digiti *arises* fleshy from the annular ligament and from the pisiform bone; its fibres run along the ulnar side of the metacarpal bone, and are *inserted* tendinous into the ulnar side of the first phalanx; its name implies its *use;* it is superficial; a few fibres of the palmaris only cover it; its origin is partly continuous with the insertion of the flexor carpi ulnaris.

Flexor Brevis Minimi Digiti *arises* from the annular ligament and unciform bone, *inserted* by a round tendon into the base of the first phalanx of the little finger. *Use*, to flex and adduct the little finger; it lies to the radial side of the last muscle, along with which it is inserted.

Adductor, or Opponens Minimi Digiti, *arises* along with, but internal to the last, and overlapped by it, and is *inserted* into all the metacarpal bone of this finger; its name denotes its *use*.

When all the flexor and extensor tendons have been removed, we observe the intervals between the metacarpal bones to be filled by muscular fibres, which are called the interosseous muscles. As there are four interosseous spaces, there must be eight of these muscles, two in each space, but one of the anterior set has been already described as the "adductor pollicis," differing from the interossei in passing across one metacarpal bone, as it proceeds from its origin to its insertion, in order to increase the extent of adduction of the thumb. One of the posterior set, also, is sometimes described as a distinct muscle, "abductor indicis," therefore some only enumerate six interossei muscles, three anterior and three posterior; we shall consider them as seven in number, three in front and four behind: their actions on the fingers are chiefly adduction and abduction; these terms are applied in reference, not to the medial line of the body, as in the description of other regions, but to the middle line or axis of the hand, which corresponds to the middle finger and its metacarpal bone; adduction is the approximation of the fingers, abduction their divarication. The anterior or palmar interossei, are adductors; their origin, or fixed point, being nearer the axis than their movable insertion; the posterior are abductors, their origin being further from the axis than their insertion; both also act on the extensor tendons, and keep these fixed to the dorsum of the fingers in the line of their phalanges, thus answering the same purpose as the sheaths in front; they may also, in consequence of this attachment, assist in the extension of the fingers, and hence it is that they have no power of acting, especially the posterior, unless the extensors are previously in action; when the fingers are bent and the hand but partially closed, we cannot separate or abduct the fingers, but the mere act of flexion adducts them at the same time. The anterior, or palmar interossei, are three in number, the adductor pollicis being excluded; they are placed on the metacarpal bones, rather than between them, are covered anteriorly by the flexor tendons and the lumbricales, by the palmar vessels and nerves, and by the deep palmar fascia, from which septa pass between these and the posterior muscles, which also project into the palm; posteriorly they are covered by the posterior interossei; one side of each is attached to the metacarpal bone, and the other is in contact with the projecting posterior muscle, the thin fascia only intervening; they each arise by a single, but a long origin, from one metacarpal bone, and are inserted into the first phalanx of the same finger, and into its extensor tendon; the first is along the ulnar side of the metacarpal bone of the index finger and inserted into its first phalanx, it will therefore adduct that finger towards the middle; the second and third are along the radial sides of the metacarpal bones of the ring and little fingers, and inserted

into their first phalanges, will also adduct those fingers towards the middle finger; the latter has no interior interosseous muscle attached to it, for obvious reasons, it being the axis towards which the other fingers are adducted.

FIRST PALMAR INTEROSSEOUS, or ADDUCTOR INDICIS, *arises* by fleshy fibres from the two upper thirds of the ulnar side of the second metacarpal bone, and from the ligament connecting it to the trapezoid; these end in a small tendon, which is *inserted* into the ulnar side of the base of the first phalanx of the forefinger and into the extensor aponeurosis. *Use*, to adduct this finger; it is covered anteriorly by the adductor and flexor pollicis brevis; the second dorsal interosseous is along its inner side.

SECOND PALMAR INTEROSSEOUS, or ADDUCTOR ANNULARIS, *arises* in like manner as the last from the radial side of the fourth metacarpal bone, and is *inserted* into the radial side of the base of the ring finger and into its extensor tendon. *Use*, to adduct the ring finger towards the middle.

THIRD PALMAR INTEROSSEOUS, or ADDUCTOR MINIMI DIGITI, *arises* from the radial side of the fifth metacarpal bone, and from the ligaments connecting it to the unciform; *inserted* into the radial side of the base of the first phalanx of the little finger and into its extensor tendon; it is covered by the opponens minimi digiti; the fourth dorsal interosseous corresponds to its radial side. *Use*, to adduct the little to the ring and middle fingers. The posterior interossei are four in number; they are longer and more distinct than the anterior; they may be seen posteriorly, filling the metacarpal intervals, also anteriorly, projecting beyond the bones and connected to the anterior interossei; the first is much the largest, and is named the

FIRST POSTERIOR INTEROSSEOUS, or ABDUCTOR INDICIS, between the thumb and forefinger; thin, flat, and triangular, the base above, the apex at its insertion; *arises* by two origins, each from the opposed sides of the first and second metacarpal bones; a tendinous arch connects these posteriorly, behind which the radial artery passes into the palmar region; the two fasciculi proceed distinct for some way, then end in a tendon, which is *inserted* into the radial side of the base of the first phalanx of the index finger and into the border of its extensor tendon. *Use*, to move this finger from the others, or from the axis of the hand towards the thumb; it also draws it forwards towards the palm; this muscle crosses behind the adductor pollicis, and is subcutaneous posteriorly; it can be felt and seen in the triangular cutaneous fold between the thumb and index finger; its palmar surface is in contact with the short flexor, and adductor of the thumb and first lumbricalis.

SECOND POSTERIOR INTEROSSEOUS, or EXTERNUS MEDII, *arises* from the opposite sides of the second and third metacarpal bones, and is *inserted* into the radial side of the middle finger, and into its extensor tendon. *Use*, to move the latter outwards or towards the index.

THIRD POSTERIOR INTEROSSEOUS, or INTERNUS MEDII, *arises* from the opposed sides of the middle and ring fingers, and is *inserted*, like the last, into the ulnar side of the middle. *Use*, to move the latter inwards, or towards the ring finger; thus the middle finger has two dorsal interosseous muscles, which individually move it to either side, but when both act, they fix it in the extended line; this finger, therefore, requires no anterior interosseous muscle.

FOURTH POSTERIOR INTEROSSEOUS, or ABDUCTOR ANNULARIS, *arises* from the opposed sides of the fourth and fifth metacarpal bones, and is *inserted* into the ulnar side of the ring finger. *Use*, to separate this from the middle finger. No posterior interosseous muscle is inserted into the little finger, unless we regard its abductor muscle as one, its use being analogous, as it co-operates with the long abductor of the thumb, and with all the posterior interossei, in divaricating all the fingers, and thus enlarging the range of surface over which the hand and fingers can extend. These three last interossei muscles are very similarly circumstanced, covered posteriorly by the integu-

ments, the extensor tendons, and their connecting transverse bands, also by a fine fascia which binds them down on a plane with the metacarpal bones; they are all somewhat triangular, or prism-shaped, and their superior, or carpal extremities, are pierced by the perforating arteries from the deep palmar arch, in the same manner as the radial artery pierces that of the abductor indicis; they all arise, by double origins, from two metacarpal bones, and are inserted singly into the first phalanx of one finger, and into its extensor tendon; one origin is from the posterior lateral surface of one bone, and the other is from the entire side of the opposite; the fasciculi are penniform, and proceed very obliquely, and their tendons pass over the metacarpo-phalangal joints, and then expand as they join the extensor aponeuroses. All these muscles are covered in front by the palmar tendons, vessels, and nerves.

From a review of the muscles of this region we may infer, that, as at the elbow, so at the wrist, hand, and fingers, the flexors predominate over the extensors; each of the four inner fingers possesses three flexors, the profundus perforans for the last phalanx, the sublimis perforatus for the second, the accessory, or lumbricalis, for the first; the latter may also flex the metacarpus, and the anterior interossei can assist these by pressing forwards the metacarpo-phalangal joints. The thumb has its long flexor, analogous to the profundus in the other fingers; it wants, however, the second long flexor, as it has not the middle phalanx; but it has a very strong short flexor, or accessory muscle, as also an opponens and an adductor, which co-operate with its flexors. Each of the four inner fingers has a long extensor, whose action is aided by the interossei and lumbricales; the index and little finger have also an additional extensor; and the thumb, in addition to the long abductor, or extensor of its metacarpal bone, has also an extensor for its first and for its second phalanx. The flexors have a tendency to adduct or approximate the fingers, and the anterior interossei and lumbricales can co-operate; while the extensors have a tendency slightly to abduct, and are greatly assisted in so doing by the posterior interossei. Although the thumb has no posterior interosseous muscle, yet its long abductor, arising in the posterior interosseous space in the forearm, is analogous, but superior in power; the index finger has its adductor, or anterior interosseus, and its abductor, or posterior interosseous; the middle, instead of an anterior, has two posterior interossei, which can fix it and move it to either side, and therefore serves to abduct or adduct it; the ring has its anterior interosseous, or adductor, and its posterior, or abductor; and the little has the anterior interosseous, or adductor, and its abductor, which, however, cannot be called an interosseous muscle.

In the dissection of the forearm and hand we meet with the branches of the brachial artery, with their accompanying veins; also branches of the brachial plexus of nerves: the cutaneous veins have been already noticed. The brachial artery, when it arrives at the bend of the elbow, divides into its radial and ulnar branches. The *radial artery* descends from the elbow obliquely outwards to the styloid process of the radius, passes over the outer side of the carpus, and then between the metacarpal bones of the thumb and of the forefinger, where it divides into three branches, radialis indicis, magna pollicis, and palmaris profunda: the radial artery at first lies between the pronator teres and supinator longus; afterwards between the supinator and flexor carpi radialis; it then winds round the carpus, over the external lateral ligament, and beneath the extensor tendons of the thumb; in the forearm it is only overlapped above by the supinator longus; in the rest of its course it is superficial; it is accompanied by two veins, and by the radial branch of the musculo-spiral nerve, which lies to its outer side. The radial artery gives off, first, the recurrent branch, which ascends in front of the external condyle, to supply the muscles attached there, and to inosculate with the superior profunda; second, in its course down the forearm, several mus-

cular branches; third, near the wrist, the superficialis volæ, which passes to the small muscles of the thumb, and communicates with the superficial palmar artery; fourth and fifth, branches to the fore and back part of the carpus: and between the thumb and index finger it divides into its three last branches; the magna pollicis subdivides and supplies the sides of the thumb; the radialis indicis, in like manner, supplies the forefinger; and the palmaris profunda passes beneath all the flexor tendons across the four metacarpal bones, forms the deep palmar arch, and then joins a branch from the ulnar artery. The *ulnar artery* is larger than the radial; it descends obliquely inwards, beneath the superficial flexors and pronators, and lies on the flexor profundus; it passes over the annular ligament into the palm of the hand, and there divides into a superficial and deep branch: this vessel is covered also by several muscles; inferiorly it is superficial, and lies between the tendons of the flexor sublimis and flexor carpi ulnaris; it is attended by its two veins, and in the inferior two-thirds of the forearm by the ulnar nerve, which always lies to its ulnar side; near the wrist this nerve is somewhat behind the artery. The ulnar artery sends off, first and second, its recurrent branches; the anterior, small, ascends in front of the internal condyle; the posterior, large, passes behind that condyle, and joins the inferior profunda; third, the interosseous artery, which, passing backwards, divides into its posterior and anterior branch; the posterior passes through the upper part of the interosseous space, and ascends in the substance of the anconæus; the anterior interosseous descends between and beneath the flexor profundus and flexor pollicis, as far as the pronator quadratus, which it supplies, and is then lost on the carpus; fourth, muscular branches; fifth and sixth, to the back and front of the carpus; and in the palm of the hand it terminates in the deep and superficial branch; the former sinks between the muscles of the little finger, to join the deep palmar arch; the superficial runs across the flexor tendons, forming the superficial arch, from the convex side of which, the long digital arteries arise; these supply the three inner fingers.—See *Vascular System.*

In addition to the cutaneous nerves already noticed, we find the median, ulnar, and musculo-spiral descending in the forearm; the *median nerve* passes between the heads of the pronator teres, and descends beneath the flexor sublimis, giving off the anterior interosseous nerve, and branches to the muscles of the forearm; it passes beneath the annular ligament, appears superficial in the palm of the hand near the thumb, and sends off digital branches, which accompany the digital arteries to all the fingers, except the little, and the ulnar side of the ring finger. The *ulnar nerve* winds round behind the internal condyle, between the heads of the flexor carpi ulnaris, and descends along the internal side of the ulnar artery to the hand, where it terminates, by dividing into a small superficial and a large deep branch. The *musculo-spiral* or *radial nerve* is seen beneath the supinator longus, descending along the outer side of the radial artery, and supplying the adjacent muscles; near the elbow it gives off the posterior interosseous nerve, and a little below the middle of the forearm it passes beneath the tendon of the supinator, and becomes cutaneous, being distributed to the integuments of the thumb and back of the hand.—See *Anatomy of the Nervous System.*

CHAPTER VI.

DISSECTION OF THE ABDOMEN.

SECTION I.

OF THE MUSCLES ON THE ANTERIOR AND LATERAL PARTS OF THE ABDOMEN.

The structures which compose the abdominal parietes, anteriorly and laterally, are the integuments, superficial fascia, muscles and tendons, a subjacent fibrous expansion, and a serous membrane; nutrient vessels and nerves ramify in and between these several laminæ; the integument is soft and smooth, but variable; in women who have borne children it is found wrinkled, and the cuticle is marked in a peculiar reticular manner.

Divide the integuments from the sternum to the pelvis, from the crest of each ilium to the umbilicus, also from this point upwards and outwards on either side over the cartilages of the ninth and tenth ribs, as high as midway between the axilla and the border of the thorax; dissect off the flaps; the subcutaneous cellular membrane will be found tense and strong, so as to have received the name of superficial fascia; this may be removed, along with the integuments, from the superior and lateral parts of the abdomen, but inferiorly and anteriorly it may be suffered to remain for further examination, a knowledge of its structure and connections being of practical importance in the disease of hernia. The *superficial fascia* is continued from the surface of the thorax, over the abdominal muscles; weak and thin above, it increases in density as it descends; from the abdomen it extends on either side over Poupart's ligament to the thigh, which it invests, and in the centre over the organs of generation; in the male a process of it passes round the spermatic cord on each side, descends into the scrotum, and is continuous with the fascia of the perinæum, and from the linea alba a thick portion runs to the dorsum of the penis, invests this organ, and serves as its superficial suspensory ligament and sheath; the processes which inclose the testes are distinct and separate, and by their contact form the septum scroti. In the female it is loaded with fat in this situation, and descends into the labia, but these prolongations of the fascia in the male are always free from adipose deposit. As this fascia passes over Poupart's ligament, it is connected to it, through the medium of a thin, transparent, but strong membrane, which ascends from the fascia lata of the thigh, and is soon lost on the abdominal muscles; to this the superficial fascia is attached, so as to give the latter the appearance of adhering to Poupart's ligament, although it really is not so. This structure is sometimes called Scarpa's fascia, as that writer has described it under the name of the "Aponeurosis of the fascia lata;" we shall call it the deep fascia of the abdominal muscles; it is always present, though very unequally developed in different subjects; some of the inguinal glands separate this from the superficial fascia, so also does a femoral hernia, in its ascent on the surface of the abdomen; though generally very thin, it imparts much strength and resistance to the tendon of the external oblique, as it adheres intimately to its fibres; this fascia is also continued, as a very delicate lamina, over the spermatic cord, into the scrotum; this accounts for the fact, that when uri-

nary effusions extend from the perinæum over the abdomen, they do not pass towards the thigh, as this membrane forms a septum between it and the abdomen. About an inch below Poupart's ligament, in the groin, the superficial adheres intimately to the fascia lata; in this situation the former is very thick and laminated, forming capsules for the inguinal lymphatic glands, and is connected to the fascia lata by vessels and nerves which perforate the latter in their course to and from these glands, the superficial fascia, and integuments; the fascia lata here also is very weak, and rather cellular, so that the superficial and deep fasciæ are continuous or identified in this situation; soon afterwards, however, they again become distinct. The superficial fascia is thinner along the sides than it is on the forepart of the abdomen; its cutaneous surface is cellular, and closely connected to the integuments, particularly in the median line; its posterior surface is more compact and smooth, and often appears to contain some elastic tissue, particularly about the lower part of the linea alba, not unlike the yellow fibrous expansion which covers the abdomen of large quadrupeds; several bloodvessels ramify between the skin and this membrane; three set on each side, viz., the external circumflex ilii, external epigastric, and external pudic arteries; these all arise in the groin, from the femoral artery, or from some of its branches, and ascend over Poupart's ligament; the first ramifies towards the anterior spinous process of the ilium; the second, which is the largest of the three, ascends towards the umbilicus; and the third passes transversely towards the pubis; these several arteries supply the integuments, and inosculate with the deep-seated vessels of the same name; they are each accompanied by one or two veins, which are often found remarkably tortuous in pregnancy or in ascites, and should be avoided in the operation of paracentesis of the abdomen; these superficial veins open into the saphena or femoral vein, below Poupart's ligament. The superficial fascia supports and connects the fleshy and tendinous fasciculi of the abdominal muscles; it also possesses some power of resistance and a good deal of elasticity, which assists these muscles in the contraction of the parietes of the abdomen; the superficial is sometimes called "Camper's fascia." Remove the integuments and fasciæ from the surface of the abdominal muscles, and continue the dissection as far back as within two or three inches of the spine. The dissection of these muscles requires much care and attention; many of them are very thin, and in such close apposition, that the unpractised hand may have some difficulty in raising their successive laminæ; some portions of these muscles also are often very indistinctly marked, particularly if the abdomen have been long distended by dropsy, or in very weak, emaciated, or anasarcous subjects. In dissecting the external oblique muscle, at its upper and anterior part, care must be taken not to raise its aponeurosis or tendon, which is so thin, as it passes over the anterior part of the thorax, that it may be mistaken for condensed cellular membrane. In order to expose the external oblique muscle, make its fibres tense by putting a block under the loins, and dissect in a line nearly parallel to its fibres; they are covered by a fine, closely-adhering, cellular coat, difficult to remove, if not already detached with the superficial fascia; to clean the posterior portion, the subject should be turned a little to the opposite side.

The abdominal muscles are ten, or five pairs.

[FIRST LAYER, ONE PAIR.

Obliquus Externus, or Descendens,	*Vide page* 168.

SECOND LAYER, THREE PAIRS.

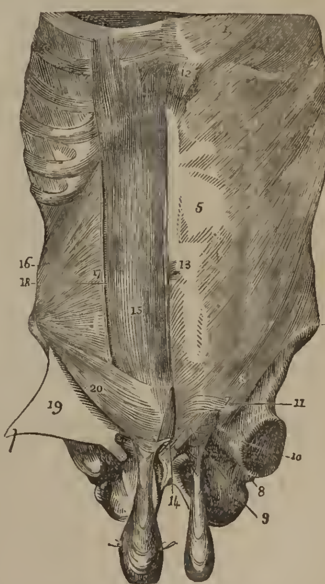
Obliquus Internus, or Ascendens,	*Vide page* 173.
Rectus Abdominis,	" 177.
Pyramidalis,	" 178.

THIRD LAYER, ONE PAIR.

Transversalis Abdominis, *Vide page* 174.]

These belong to the class of flat muscles, like the latissimus dorsi and serrati, the diaphragm and the levator ani; they are placed in three laminæ, one beneath the other, and it is important to observe that the fibres of one layer decussate those of the other two; thus those of the external oblique descend obliquely forwards, those of the internal ascend obliquely forwards, and those of the transversales are circular, while in front those of the recti are vertical, and resemble longitudinal pillars opposed to the spine; the three lateral muscular layers are closely connected together by short cellular tissue, with very little adeps, and their tendinous expansions anteriorly are perfectly interlaced; thus a very compact and resisting tissue is constructed out of thin and weak materials; the fleshy fibres, though not actually interwoven, yet in effect resemble a platted texture which prevents their divarication, and the consequent protrusion or hernia of any of the inclosed viscera. If the finger be introduced through an opening made in the side of the abdomen, even where the integuments have been removed, and an effort made to protrude it through the parietes, the resistance will be found very considerable, and such as, during life, must be fully competent to prevent a separation of the fibres from any natural cause; accordingly hernia occurs only in those situations where a natural weakness or deficiency exists, except in very rare instances, where the parietes have been injured by wound or disease, or much debilitated by long distension and absorption of all adipose substance from the tendinous interstices; hence this laminated and decussating arrangement is vastly superior to a simple circular muscle, the parallel fibres of which would be much more easy of separation, unless it possessed considerable thickness, which, however, would have been not only inconvenient but even inferior to the present plan in power and variety of action; the several laminæ are now enabled to effect, not only a general and equable compression of the abdomen, but can also assist in a variety of most useful motions of the body with considerable effect. The fibres of some laminæ being oblique, and, therefore, longer than if they were circular, possess a greater degree of contractile force; and as the fibres of one lamina have an origin, course, and insertion different from those of another, and as they can act either independently or in conjunction with the muscles on the same side, or with those on the opposite, which correspond in direction, and as both of these again may co-operate with, or antagonize other laminæ, and may act or rest reciprocally, a composition of forces is thus gained, from which must proceed an endless variety of results; thus, while all concur in compressing the abdomen, the transversi and recti do so

Fig. 36.*



* The muscles of the anterior aspect of the abdomen; on the left side the superficial layer is seen, and on the right the deeper layer. 1. The inferior portion of the pectoralis

more directly; in expiration, in like manner, though all are concerned and press the viscera upwards and backwards, against the diaphragm, yet the obliqui are most efficient, as they also depress and adduct the ribs; and again, while the entire group strengthen and support this division of the body, whose only fixed basis is the lumbar spine, some can especially steady and balance it laterally, others bend it forwards, or to either side, and others, by rotating the lumbar vertebræ, can move the whole body, as well as the pelvis and lower limbs, in almost all directions, so that no group of muscles can assist in a greater variety of purposes than those of the abdomen, although their name and their connection with this cavity, may give rise to the impression, that their chief office is to assist in its functions, yet, most probably, this is but their secondary use; it is rather as locomotive agents, as pelvi-thoracic muscles, they claim most attention; in ordinary expiration, little more than their elasticity is required, though occasionally their full contractile power is called forth; so in the function of the abdominal organs, the transverse or circular lamina, which has some resemblance to the involuntary muscles, is most influential, yet in occasional efforts, such as vomiting, defæcation and parturition, they all contribute to compress the viscera, and to contract the cavity. The abdominal parietes will be found chiefly tendinous posteriorly and anteriorly, and fleshy on either side; the anterior region is the most extensive, and the tendinous and fleshy strata which bind it are so arranged and proportioned, as to secure, to a certain extent, an equal degree of support, resistance, and contraction throughout; thus the external oblique is tendinous below and fleshy above, the internal is tendinous above and fleshy below, and the transverse is fleshy above and below, and tendinous in the centre; the student may again peruse these preliminary observations after the dissection of these muscles.

Obliquus Externus, or Descendens, broad, thin, and somewhat square, extends over the anterior and lateral parts of the abdomen, fleshy above and behind, tendinous before and below: some describe (unnecessarily in my opinion) the tendons of the oblique and transverse muscles as a distinct structure, and name it "anterior abdominal aponeurosis," as opposed to the posterior or lumbar, and composed of three, or, more accurately, of four laminæ; it *arises* by eight or nine triangular fleshy slips (sometimes there are only seven) from the lower edges and external surface of the eight or nine inferior ribs, at a little distance from their cartilages; the five superior indigitate with corresponding portions of the serratus magnus; and the three inferior with those of the latissimus dorsi, by which they are a little overlapped; this serrated origin is in the form of a long curved line, the concavity upwards and backwards. The superior fibres are thin, aponeurotic, and weak, and pass horizontally inwards; a tendinous and fleshy slip often connects this portion to the great pectoral muscle; the middle are the longest, and descend obliquely forwards and inwards in the same line as the external intercostals; the posterior are strong and fleshy, and descend almost vertically; the supe-

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major muscle. 2. The inferior indigitations of the serratus magnus muscle. 3. The external oblique muscle. 4. The anterior part of the crest of the ilium. 5. The aponeurosis of the external oblique passing in front of the rectus abdominis muscle. 6. The inferior border of the aponeurosis of the external oblique, forming what is termed the crural arch. 7. The intercolumnar bands. 8. The external abdominal ring. 9. The superior and internal pillar of the ring. 10. Gimbernaut's ligament. 11. Space beneath the crural arch or Poupart's ligament, through which pass muscles, vessels and nerves. 12. The xiphoid cartilage. 13. The umbilicus. 14. The pyramidalis muscle. 15 The rectus muscle. 16. The internal oblique muscle. 17. The anterior layer of the tendon of the internal oblique, which passed in front of the rectus muscle, cut away close to its origin. 18. The posterior layer of the same tendon passing behind the rectus muscle. 19. The internal surface of the aponeurosis of the external oblique thrown downwards. 20. The inferior fibres of the internal oblique.

rior and middle fibres end in a broad tendon, which commences at a little distance external to the linea semilunaris; the outer border of this tendon extends in an irregularly concave line from the cartilage of the eighth rib, to the anterior superior spine of the ilium; this line is external and differently curved to the linea semilunaris; the tendon is continued over the forepart of the abdomen, covers the rectus muscle, and is so broad inferiorly, as, when taken with its fellow, to extend from one spine of the ilium to that of the opposite side; it is very strong inferiorly, but so very thin above, where it covers the thoracic portion of the rectus, that the inexperienced dissector often removes it along with the integument. The external oblique is *inserted* tendinous into the ensiform cartilage, linea alba, pubis, Poupart's ligament (which is formed by a thickening and reflection or folding back of the lower fibres of this tendon), and into the anterior superior spinous process of the ilium, also tendinous and fleshy into the outer edge of the two anterior thirds of the crest of the ilium. *Use*, to depress and adduct the ribs, and compress the abdominal viscera, so as to assist in expiration, and in the evacuation of the urine and fæces. When both muscles act, they can bend the trunk forwards; if only one act, it will bend it to that side, and it may also rotate it to the opposite side; if the thorax be the fixed point, they can bend forwards and upwards the pelvis, and each can rotate it towards its own side. This muscle is covered by the skin and superficial fascia, its posterior border is sometimes overlapped by the latissimus dorsi; in some cases, however, these muscles do not meet, and a small part of the internal oblique is seen in the triangular space between them; in this space a lumbar hernia has been known to have occurred; in some forms of lumbar abscess, also, I have found the tumor to bulge towards the surface in this interval, which was then enlarged. On the dissected tendons of this pair of muscles, we may remark the following particulars: the linea alba and umbilicus, lineæ semilunares, lineæ transversæ, the external abdominal or inguinal rings, and Poupart's ligament on each side. The *linea alba* is a dense ligamentous cord, extending from the ensiform cartilage to the upper part of the simphisis pubis; it is formed by the intimate union and crossing of the tendinous fibres of the two oblique and transverse muscles of opposite sides; inferiorly, however, the fibres of the opposite tendons only cross to be inserted into the opposite pubis, but do not unite or interlace; its greatest breadth and thickness are at the umbilicus, from this to the pubis it decreases; its superior portion is much broader than its inferior; as the recti muscles are there so close together, it is reduced to a mere line, whereas above, particularly in corpulent persons, it is often half an inch broad; in its infra-umbilical portion, where the decussating fibres of the tendons are less distinct, there is also a long, narrow, fibrous cord, which commences gradually a little below the umbilicus, and extends to the ligamentous covering of the pubes; in very thin subjects this projecting cord can often be seen and felt through the skin; as the linea alba is so narrow below, the abdomen is stronger in the middle region than above; resistance and contraction being there more necessary, and here, therefore, hernia never occurs; the integuments are more closely connected to this line, than they are at either side; hence the more fat the subject, the more indented will the skin appear along it. About the centre of the linea alba, or a little below it, is the *umbilicus;* this, in the fœtus, was a foramen, through which were transmitted the umbilical vein from the mother, and the umbilical arteries and the urachus from the child; before the integuments were removed, this spot appeared depressed, particularly if the subject have been very fat; it now projects, and seems formed of dense, cicatrized, and cellular tissue, surrounded by, and connected to the adjacent tendinous fibres, and plugged up by the ligamentous remains of the three bloodvessels which diverge from its posterior surface. Umbilical hernia occurs in the infant

through this opening, but in the adult in its immediate vicinity; posteriorly the peritoneum is in contact with the linea alba above, but below, the urachus, and occasionally the urinary bladder intervene. Several small openings exist in this line, through which bloodvessels pass and fatty masses protrude, and sometimes a small pouch of peritoneum; the linea alba is increased in breadth, and becomes proportionately weak when the abdomen has long suffered distension from any cause.

The linea alba is regarded by some as the continuation of the sternum, which, in some animals, is extended to the pubes; it serves as a fixed point for the oblique and transverse muscles on either side, also as a resisting, but not an elastic ligament, to connect the thorax to the pelvis, and to support the former when bending the trunk backwards, so as to resist or prevent too forcible extension of the spine. In the inferior part of this line the following operations may be performed: puncturing the bladder in retention of urine; paracentesis, or tapping of the abdomen, in ascites; and the high operation for lithotomy.

The inferior fourth or fifth part of the linea alba is sometimes deficient, as also a portion of the muscles on each side, so that the urinary bladder is superficial, and constantly exposed; in such cases the anterior part of this viscus also is wanting, and therefore its cavity and the orifices of the ureters can be perceived during life.

The *lineæ semilunares* extend from the tuberosity of the pubis on each side upwards and outwards, about four inches from the linea alba, towards the cartilages of the eighth and ninth ribs; they appear white, and somewhat depressed, and are formed by the tendons of the internal oblique, dividing at the edge of each rectus into two layers, to inclose this muscle in a sort of sheath; the space inclosed between these two lines is oval, the larger end above; it contains the two recti and the linea alba. In the living subject this line may be traced by taking a point midway between the umbilicus and the anterior superior spinous process of the ilium, and from it drawing one line towards the tuberosity, or spine of the pubis, and another towards the cartilage of the ninth rib. The operation of tapping ovarian dropsy should always be performed in this line; and this situation is also selected by some as the best for performing paracentesis in cases of ascites. In this last-mentioned disease, however, this line is not exactly midway between the umbilicus and spine of the ilium, but half an inch nearer the latter, as the recti become flattened and expanded laterally.

The *lineæ transversæ* are three or four on each side. they cross the rectus muscle from the linea alba to the linea semilunaris; they are tendinous intersections of that muscle, particularly of its anterior part, which adhere so intimately to its sheath, as to give to the latter this indented appearance. They are much better marked in some than in others; during life they are very distinct, when the abdominal muscles are in strong action; one of these corresponds to the umbilicus, another to the ensiform cartilage, the third is midway between these; if a fourth or fifth exist, they are inferior to the umbilicus and but feebly marked. These lines will be again noticed in the dissection of the rectus. Between the linea alba and semilunaris on each side many small holes are often to be observed in the tendon of the external oblique, these are only for the transmission of small vessels and nerves, are generally of a square form, and are much larger and more numerous in some than in others; the fasciculi of the tendon also occasionally separate in a very variable manner, leaving triangular spaces between them, and in many situations they are intersected at various angles by other tendinous fibres.

The *external inguinal*, or *abdominal ring*, also named *by some anterior*, and by others, *inferior*, transmitting, in the male, the spermatic cord and cremaster muscle, with its vessels and nerves, and in the female the round liga-

ment of the uterus, is situated external and superior to the pubis on either side. This opening is of an oval or triangular form, the base is inferior and internal at the pubis, the apex is superior and external in the tendon, and formed by the separation of its fibres; the sides are called the pillars of the ring, one of which is superior, internal, and anterior; the other, or Poupart's ligament, is inferior, external, and posterior. The first, or superior pillar, is broad, and inserted into the symphysis and into the opposite pubis; some fibres are continuous with the fascia lata of the opposite thigh; this pillar decussates with that of the opposite side, on the forepart of the pubis, and both send fibres to the dorsum of the penis; the inferior pillar is the internal or pubic end of Poupart's ligament; the dimensions of this opening (improperly called a ring) are very variable, transversely they are about half an inch, and from an inch to an inch and a half from within and from below, upwards and outwards; it is larger in the male than in the female. The apex of this opening is rounded by a series of fibres, which serve to connect the pillars to each other. These fibres arise from Poupart's ligament at a little distance from the spine of the ilium, pass in curved lines upwards and inwards across the upper part of the ring, and are lost superiorly on the surface of the tendon; they serve, by preventing the separation of the sides of the ring, to protect this part of the abdomen against a protrusion of its contents; the same order of fibres continue their attachments to the margins of the opening, and are prolonged inferiorly as a fine membrane on the spermatic cord; in cases of long existing hernia this fascia becomes much developed, and forms one of the coverings of the sac, and is found closely connected to the subjacent cremaster muscle. Anatomists have given to the whole of this structure the appropriate name of *intercolumnar fascia;* some, however, divide it into two, and name the superior fasciculated portion, "intercolumnar bands, or fascia," and the inferior membranous portion, "spermatic, or cremaster fascia;" as, however, these two are so connected, and so allied in their use, we shall consider both as the intercolumnar fascia, only observing, that the superior portion is more distinctly tendinous and fasciculated, and the inferior more membranous; if we separate this structure from the tendon and from the margins of the ring, commencing above, we can demonstrate the whole as one continuous tissue extended indefinitely along the cord. It is this fascia, or these intercolumnal bands, that obscure this opening in many cases, and deprive it of that defined figure usually mentioned by writers, or delineated in plates. The tendon of the external oblique is alone concerned in the formation of the external abdominal ring, there being no corresponding deficiency in the internal oblique or transverse muscles; the spermatic cord, or round ligament, must therefore have taken an oblique course to arrive at this opening; this will be seen in the next stage of the dissection.

Poupart's, or *Fallopius' ligament*, or the *femoral*, or *crural arch*, is the inferior edge of the tendon of the external oblique, thickened and reflected upon itself from before backwards; it is very strong, and when the lower extremity is extended, and the foot and toes everted, it appears very tense, and convex downwards and outwards; it corresponds to the fold of the groin, separates, superficially, the abdomen from the thigh, and bounds anteriorly the large triangular or semilunar space, which the ilium and pubis complete posteriorly, and which space is occupied from without inwards by the iliac and psoas muscles, with the anterior crural nerve, the femoral artery and vein, internal to which are some cellular tissue, lymphatic vessels, and sometimes a lymphatic gland, also the origin of the pectinæus muscle. If we consider it as a distinct ligament, it may be described as having an attachment to, or as *arising* from the anterior superior spinous process of the ilium, thence it at first descends obliquely, and then proceeds forwards and inwards

to the pubis, into which it is *inserted* by two attachments, one anteriorly into the tuberosity or spine, and into the forepart of the bone beyond this process; the other, which consists of the reflected fibres of the tendon, is narrow at first where it is folded in under that last described, and then expands and is inserted behind it, being continuous with it, partly into the spine, and principally into the prominent linea innominata of the pubis, or the commencement of the linea ileo-pectinea; by means of this reflection backwards of these lower fibres, a sort of groove or channel is formed, which lodges the spermatic cord, supports it below, and separates it from the thigh; the oblique tendon itself forms the front of this channel; this is named the spermatic, or inguinal channel, and will be more fully seen hereafter. The first, or iliac end of Poupart's ligament is broad and continuous above with the tendon of the oblique, and below with the fascia lata; the anterior portion of the pubal end, or the *second* insertion, is distinct and round, and can be felt through the skin; it lies behind the cord, and is connected to that portion of the fascia lata which covers the adductor muscles; the posterior pubal attachment, or the *third* insertion, also called *Gimbernaut's ligament*, is broad and thin, and lies superior, posterior, and external to the former; it may be seen by raising the cord out of the external ring, and everting Poupart's ligament a little; it is of a triangular form, the apex is anterior, at the tuberosity, or spine of the pubis; the base is external and posterior, somewhat crescentic, looking towards the femoral vessels; to it some fibres from the outer, or iliac part of the fascia lata, are attached, so as to elongate it in this direction; this third insertion of Poupart's ligament forms the internal boundary of the femoral ring, and is therefore concerned in the anatomy of femoral hernia, as will be seen hereafter. Poupart's ligament owes much of its strength to its connection with the fascia lata of the thigh, as may be seen at present by merely flexing the limb and inverting the knee, the ligament then becomes relaxed, as also the parietes of the ring; hence this position is constantly resorted to, and often successfully, in attempting the reduction of inguinal hernia; it is this connection to the fascia lata which gives it the arched, or curved appearance, convex towards the thigh, and which curve is straightened when the limb is bent and adducted; it is also curved in another direction, concave forwards and convex backwards towards the iliac fossa; this curvature depends on the intimate union between this ligament and the fascia iliaca and transversalis, which adds materially to the strength of this region; and as the iliac fascia is also connected to that of the thigh, the position of the latter will alter or relax this curve as well as the former; these curvatures are well marked during life in the strong and muscular man: its attachment to the fascia transversalis and iliaca will be exposed in a future stage of the dissection. Poupart's ligament is of *use* in strengthening the inferior part of the abdomen, and affording a fixed point of attachment to the deeper muscles and to the different aponeuroses; it also protects the great femoral vessels and nerves in their passage from the abdomen to the thigh, and its third insertion partially fills up the internal portion of the crural arch. From this third insertion, and from the pubis, a band of fibres may be observed to pass upwards and inwards, behind the superior pillar of the ring, towards the linea alba; these assume in general a triangular shape, and have received the name of the *triangular ligament*, or *fascia*; the base is inferiorly at the linea ileo pectinea; the apex is superior and internal towards the linea alba, and is continuous with the external oblique tendon of the opposite side; this fascia serves to protect the abdomen in this region; this, though delineated by others, has been first particularly described in Colles' *Surgical Anatomy*, and is therefore commonly called "*Colles' fascia*;" though described as a distinct structure, it really is only a continuation of the decussating fibres of the opposite tendons, as all through the linea alba above; in fact, each of these ligaments is

but a stronger portion of the external oblique tendon of the opposite side, and might be correctly described as arising from it in the linea alba, then expanding as it descends to its insertion in the opposite ileo-pectineal ridge; it not only protects the abdomen behind the external ring, but it ties together all the surrounding textures, and confines them towards the linea alba; it may be said to connect the superior pillar of one ring with the inferior pillar of the opposite; it lies directly behind the cord, and is anterior, but inseparably united to the conjoined tendons of the internal oblique and transversalis, in front of the rectus; its development as to strength and extent is very variable, in some it is so weak as scarcely to deserve notice. Raise the external oblique, by dissecting off its serrated origins from the ribs, detach also its insertion from the crest of the ilium, and from the internal oblique muscle, cleaning at the same time the surface of the latter, throw the external oblique towards the opposite side, separating it as far forwards as its connections will permit, that is, about half an inch internal to the linea semilunaris; divide its tendon transversely from the spine of the ilium, towards the lower third of the rectus, about an inch above the external ring, thus preserving Poupart's ligament and the external ring for further examination, in relation to the anatomy of hernia; numerous small nerves and vessels are met with in this dissection; several perforate the tendon near the linea alba, and several also pass through its fleshy costal portions. When the external oblique is raised, we see the inferior ribs, the inferior intercostal muscles, the internal oblique, and the cremaster.

Obliquus Internus, or Ascendens, is also situated at the anterior and lateral part of the abdomen, broader before than behind, and more fleshy below than above; it *arises* tendinous, but soon becomes fleshy, from the fascia lumborum, from all the crest of the ilium, and from the two external thirds of the grooved, or abdominal surface of Poupart's ligament; the fibres diverge in a radiated manner; those from the lumbar fascia and posterior part of the ilium ascend obliquely forwards; those from the anterior part of the ilium pass transversely, and those from Poupart's ligament descend obliquely inwards; the fibres continue fleshy further forward than those of the external oblique; at the linea semilunaris they end in a flat tendon, called by some the middle layer of the anterior abdominal aponeurosis; at the edge of the rectus this divides into two layers to inclose this muscle; the anterior is united to the tendon of the external oblique, the posterior and thinner layer is joined to the tendon of the transversalis; this does not extend so high as the anterior; it commences on a level with the cartilage of the seventh or eighth rib only, so that above this point the rectus rests on the transverse muscle, which here continues fleshy for a little way internal to the linea semilunaris; about midway between the umbilicus and the pubis, the tendon of the internal oblique does not divide, but the whole passes in front of the rectus, along with the tendon of the transversalis, to which it is closely connected; a little above the pubis these two tendons are intimately joined, and are called the *conjoined tendons.* The internal oblique is *inserted,* fleshy, into the cartilages of the four inferior ribs, the fibres meeting the internal intercostal muscles, to which they are parallel; tendinous into the ensiform cartilage, and into that of the seventh and eighth ribs, also into the whole length of the linea alba; the conjoined tendons are *inserted* into the symphisis and upper edge of the pubis, and, passing external to the rectus, are also inserted into the linea innominata, where they are connected with Gimbernaut's ligament, and inseparably joined to the fascia transversalis; while the inferior fleshy fibres pass anterior to the spermatic cord, these conjoined tendons lie posterior to it, also to the triangular ligament, and thus afford much security not only to that part of the abdomen behind the external abdominal ring, but also to the inguinal channel generally. The *use* of the internal oblique muscle is to assist the external

oblique in expiration by depressing the ribs, and by compressing the abdominal viscera, also to bend the trunk forwards, or to one side; it can also rotate the trunk, but in doing so, it co-operates with the external oblique of the opposite side, with which it forms a sort of digastric muscle; this muscle is covered by the external oblique and latissimus dorsi; it lies on the transversalis muscle; some small vessels ramify between them; a small portion of the internal oblique is sometimes superficial, between the external oblique and latissimus dorsi, above the posterior part of the ilium; the lower semilunar border is variable in strength and extent, it sometimes covers the cord as low as the external ring; along this inferior border we observe the following muscle.

Cremaster, or Suspensorius Testis, consists of a fasciculus of pale fleshy fibres, which *arise* from the internal surface of the external third of Poupart's ligament, and from the lower edge of the last described muscle; a few fibres also sometimes proceed from the lower edge of the transversalis muscle; it frequently, too, has a tendinous attachment to the pubis, behind the external abdominal ring; this fourth mentioned attachment, perhaps, rather deserves the name of insertion; the fibres all pass downwards and forwards around the spermatic cord, but chiefly along its outer side, many of them in the form of arches reversed, or concave upwards; they are *inserted* into the tunica vaginalis; a few fibres are lost in the scrotum. *Use*, to support, compress, and raise the testicle and its vessels; the origin of this muscle is covered by the tendon of the external oblique, and lies on the fascia transversalis; a small but long nerve, a branch from one of the lumbar nerves, runs between its fibres; the lower part of the muscle is superficial and very pale; in cases of old hernia, the fibres of the cremaster are found greatly increased in thickness, and are often of a yellow color; and in that form of the disease called the oblique, or common inguinal hernia, this muscle always forms one of the coverings of the sac. The cremaster is absent in the female, or at least only rudimental. This muscle is probably formed incidentally; the testis, in its descent to the scrotum, carrying before it the lower border of the internal oblique; this will account for the arched direction of some of its fasciculi; it is usually, but not always, much developed in cases of old inguinal, or scrotal hernia, also of hydrocele; if an opportunity occur for examining it in the latter, it may be sometimes found, as described by different writers, to consist of two fasciculi, *one* descending from the inside of Poupart's ligament, having arisen from it and from the internal oblique, along the external and anterior sides of the cord, as low as the tunica vaginalis testis, on the surface of which it bends upwards, and becomes the *other*, or the ascending fasciculus, which rises along the inner and posterior sides of the cord, and is inserted into the pubis by tendinous or cellular tissue; the continuity of these fasciculi is seldom satisfactorily seen; during their course along the cord they are connected by fibrous loops, or arches, concave upwards. Raise off the internal oblique from the transversalis muscle; commence above the anterior part of the crest of the ilium, where the muscles are separated by cellular membrane, and some branches of the circumflex ilii vessels, make one incision from the ilium towards the cartilage of the ninth rib, and another from the ilium towards the lower third of the linea semilunaris; carefully dissect off the posterior part of the muscle, towards the spine, and the anterior towards the rectus; this portion can be separated from the transversalis, a little beyond the linea semilunaris.

Transversalis, somewhat square, broader anteriorly than posteriorly, *arises* tendinous from the fascia lumborum and the posterior part of the crest of the ilium, fleshy from the remaining anterior part of the crest, and from the iliac third of Poupart's ligament; it also arises tendinous from the two last ribs, and by fleshy slips from the inner side of the five succeeding; these indigitate with the origins of the diaphragm; all the fibres pass transversely forwards, except the most inferior, which are curved a little downwards; they all end

in a flat tendon, which, near the linea semilunaris, joins the posterior lamina of the internal oblique, and is *inserted* along with it into the whole length of the linea alba, into the upper edge of the pubis, and into the linea innominata; this tendon passes behind the rectus superiorly, but inferiorly, that is, about midway between the umbilicus and the pubis the conjoined tendons pass anterior to this muscle, and are *inserted* in the manner before mentioned. The transversalis abdominis is covered by the internal and external oblique; it lies on the fascia transversalis and on the peritoneum. *Use*, to compress the abdominal viscera in the circular direction, and to assist in expiration; it can also make tense the lumbar fascia, and approximate the anterior abdominal aponeurosis to it; its fleshy fasciculi are weaker and paler than those of the obliqui; they are frequently separated by interstices, in which the peritoneum and its cellulo-fibrous covering appear; the fasciculi are connected to the latter by little slips, or processes, which are very distinct, and which closely attach this muscle on each side to the lining membrane of the abdomen; it is a perfect constrictor of this cavity, and appears a sort of transition muscle between the voluntary or parietal muscles external to it, and the involuntary or visceral muscles within. This muscle is tendinous before and behind, fleshy in the middle, also above and below, contrary to the two oblique muscles; the posterior tendon is described by some, as dividing into three layers, which are, in fact, the three sheets, or leaves, of the lumbar fascia; the posterior, very strong, is continuous with the fascia lumborum: the middle, thinner and weaker, is attached to the transverse processes of the lumbar vertebræ; and is separated from the former by the lumbar muscles; and the anterior lamina, which is the weakest, is expanded over the quadratus lumborum, and the inferior part of the diaphragm, and is connected to the sides of the bodies of the lumbar vertebræ. The anterior inferior edge of the transversalis is in some degree confounded with that of the internal oblique, particularly at their origin from Poupart's ligament; its fleshy border, however, very seldom descends so low as that muscle; it crosses the cord or round ligament, just as either of these is about to pass through the internal or superior abdominal ring in the fascia transversa-

Fig. 37.*

* A transverse section of the abdomen, to show the relations of the abdominal muscles and their aponeuroses with each other, and with the neighboring parts. 1. The upper surface of the body of the second lumbar vertebra. 2. A portion of the psoas magnus muscle. 3. A transverse section of the rectus abdominis muscle. 4. The cut edge of the external oblique muscle. 5. The internal oblique muscle. 6. The transversalis muscle. 7. The latissimus dorsi muscle. 8. The quadratus lumborum muscle. 9. The mass of muscle common to the sacro-lumbalis and longissimus dorsi muscles. 10. The aponeurosis of the internal oblique uniting itself to that of the transversalis muscle. 11. The posterior aponeurosis of the transversalis muscle dividing into three laminæ. 12. The anterior lamina of the aponeurosis of the transversalis passing in front of the quadratus lumborum to its insertion at the root of the transverse process of the vertebra. 13. The middle layer of the same aponeurosis, passing behind the quadratus lumborum and in front of the lumbar mass of muscles, to be inserted into the apex of the transverse process. 14. The posterior layer of the same aponeurosis passing behind the lumbar mass of muscles to be inserted into the extremity of the spinous process of the lumbar vertebræ. 15. The aponeurosis of the external oblique terminating in the linea alba. 16. The anterior aponeurosis of the internal oblique separating into two layers at the external border of the rectus muscle. 17. The reunion of the same layers at the linea alba.

lis; the internal oblique is on a level with the lower border of this opening and therefore conceals it; the transversalis is parallel to its upper, and only partially covers it, and is often connected to the cord at this point, in a manner we shall consider presently. The conjoined tendons generally admit of partial separation near the pubis and behind the external ring; the tendon of the transversalis being broader and stronger than that of the oblique, its fibres may be observed to expand and curve downwards and outwards behind the cord, nearly as far as opposite the inner margin of the internal ring; this expansion is inserted, along with the oblique tendon, into Gimbernaut's ligament, and more externally into Poupart's ligament behind the cord, its transverse extent being from the rectus internally to a point externally below the internal ring; the lower muscular fibres will be found to pass obliquely inwards above and before the cord, and then bending downwards, and a little outwards, end in this tendinous expansion behind it; occasionally some fleshy fibres descend on or among the tendinous, and are inserted into the pubis or into Poupart's ligament; to the posterior surface of this tendinous expansion the fascia transversalis is intimately attached; this peculiar arrangement of the lower border of this muscle, its fleshy fibres being above and in front of the cord, and its tendinous expansion curving below and behind it, has been particularly noticed by Sir A. Cooper, in his paper on the descent of the testis; it appears designed to enable this muscle, when in action, to close or contract this opening, as also the inguinal canal, and thereby protect this part of the abdomen against protrusion of its contents. When we proceed to raise the lower fleshy border of the transversalis, we shall often find a peculiar attachment between it and the cord, as the latter is about to pass through the internal ring; this attachment, according to Mr. Guthrie,* depends on a few fibres of the muscle passing behind the cord at this point, these then, descending inwards, join the tendon of the muscle in its course to Poupart's ligament, so that the cord actually splits the lower border of the transversalis, a small fasciculus only passing behind or between it and the fascia, and rounded so as to support it; thus a sort of transverse elliptical opening exists near the inferior border of this muscle, through which the cord passes; this posterior fasciculus is not in all cases fleshy, but only tendinous or cellulo-fibrous, connected, however, externally to the muscle, and internally to its tendinous expansion; this structure is of considerable importance, it fortifies the abdomen against hernia, and when this has occurred, it must not only exercise much influence on the tumor, but it also suggests practical hints for its treatment; this slit Mr. Guthrie proposes to call the internal abdominal ring, instead of that passage through the transverse fascia which is directly behind it; it does not, however, appear to me advisable to adopt this innovation as to name, although me may concur with much of the description. Since the publication of Mr. Guthrie's memoir, I have paid much attention to the anatomy of this part, and I freely admit that in many instances I have found his statement perfectly correct; not long since I demonstrated the cord passing through the lower border of this muscle, and surrounded by an almost perfect sphincter. I have lately also seen the same formation in a fœtus, and I have also observed the round ligament to pass through it, and to have muscular fibres prolonged upon it, which must have had the power, not only of compressing, but also of retracting this substance. I have also sometimes seen a distinct muscular fasciculus arising by a tendon from Poupart's ligament near the ilium, thence passing behind the cord to join the common insertion; and I believe that this, or some such connection between the cord and the transversalis muscle would be more frequently detected, if we dissected the parts from within outwards, that is, first draw down the flap of the abdominal parietes,

* Guthrie on inguinal and femoral Hernia.

then raise off the peritoneum, and separate and examine the several laminæ of fasciæ, muscles, and tendons towards the skin. I must, however, observe, that the structure just described is by no means uniform; I have often carefully looked for it and in vain. I have, no doubt, frequently noticed a feeble cellulo-fibrous band passing behind the cord, and connected to the muscle and its tendon, by its extremities; it may have been that this band had been originally muscular, and had degenerated in course of time; in other cases this also has been wanting, and the lower border of the muscle has had no connection whatever, direct or indirect, with the cord, and has not even descended to within an eighth of an inch of the internal ring; experience induces me to affirm, that not only is this particular structure extremely variable, but many other parts also in this region, so that the student will seldom find the appearances presented on dissection to correspond exactly with the descriptions or delineations of any author; he should, therefore, make frequent examinations of this region for himself, as in that way only can he hope to obtain an accurate and satisfactory knowledge of this intricate but important subject. Replace the oblique muscles, divide their tendons along the side of the linea alba, and dissect them off the rectus towards the linea semilunaris; this anterior part of the sheath adheres so closely to the lineæ transversæ, that it is difficult to separate it from them.

Rectus, long and flat, broad and thin above, thick, strong, and narrow below, *arises* by a flat tendon, which is sometimes double, from the upper and anterior part of the pubis, between the spine and symphysis; the external tendon is the larger; it also sometimes receives fibres from the linea alba, which decussate with the opposite: the size and extent of its origin depend on the presence or absence of the pyramidal muscles; it *ascends* parallel to to its fellow, becomes broad but thin above the umbilicus, and is *inserted* into the anterior part of the thorax by three fasciculi, the internal one of which is fixed to the cartilage of the seventh rib, and costo-xiphoid ligament; the middle, longer and thinner, to the cartilage of the sixth rib, and the external, still broader and thinner, to the cartilage of the fifth rib; occasionally a small fasciculus is attached to the ensiform cartilage, and it is by no means uncommon to find a slip continued into the great pectoral; more rarely this passes over it, and extends to the clavicle, or to the clavicular portion of the sterno-mastoid muscle. *Use*, to bend the chest towards the pelvis, or to raise the latter towards the chest, also to compress the abdomen. The rectus is covered superiorly by the great pectoral, in the middle by the tendon of the external, and the anterior layer of that of the internal oblique muscle, and inferiorly by the external oblique, and the conjoined tendons of the internal oblique and transversalis, also by the pyramidalis; the fascia transversalis is closely attached to the outer edge of its inferior portion. These muscles are much nearer to each other below than above; they are each inclosed in a distinct sheath, which consists, anteriorly, of the tendon of the external oblique, and the anterior lamina of the internal oblique, posteriorly of the posterior layer of the internal oblique, and the tendon of the transversalis. The *sheath* commences at the edge of the thorax, and terminates midway between the umbilicus and the pubis; below which all the tendons pass anterior to this muscle. If this part of the rectus be divided, the deficiency in the back of the sheath will be obvious, as it generally terminates abruptly by a lunated edge; in some cases, however, it ends gradually in a thin tendinous expansion; the epigastric vessels ascend within this sheath, on the posterior surface of the muscle; the posterior wall of the sheath is also deficient superiorly on the thorax; the internal mammary vessels enter it above its superior posterior border, as the epigastric do below its inferior. The sheath of the rectus serves to confine this muscle in its proper place, and to prevent it, when contracted, from injuring the abdominal viscera immediately behind it; it

also strengthens the parietes of the abdomen, and prevents the more frequent occurrence of hernia; the deficiency in the back part of the sheath below may permit the abdominal muscles to exert more direct influence on the uterus, also on the urinary bladder when distended. In wounds of the parietes in this situation, with protrusion of the intestines or omenta, we should take care, in returning them into the cavity, that they do not slip into this sheath behind the muscle; the finger should, therefore, follow the last portion, and by moving it laterally, the true course will be easily ascertained. The rectus is intersected by three or four irregular, or zigzag, transverse, tendinous lines; one of these *lineæ transversæ* is always to be found opposite the umbilicus, a second midway between this and the xiphoid cartilage, opposite to which a third is always placed; if a fourth exist, it will be found below the umbilicus; these intersections are not complete; they are generally deficient on the back part of the muscle, hence the posterior fasciculi are longer than the anterior; the anterior part of the sheath, and the linea alba, adhere intimately to each of them; by means of these lines the rectus is constituted a sort of poligastric muscle; the fibres of the first muscle arising from the anterior surface of the thorax, and inserted into the first intersection, or linea transversa; the second arising from this point, is inserted into the second intersection, and so on in succession; although the posterior fibres are not thus regularly interrupted, yet they do not continue the entire length of the muscle; some of the anterior fibres also occasionally pass over one intersection without being entangled in it; this structure enables the rectus to act in distinct or separate portions, so as to compress different parts of the abdomen in succession, each section having a distinct nerve; it also imparts considerable strength and resistance to the anterior abdominal aponeurosis, and to the linea alba, while, moreover, it associates in a most important manner, the recti with the lateral muscles, so as to enable them, not only to co-operate, but reciprocally to balance and moderate each other; when the recti contract, the viscera are pushed backwards and pressed out laterally, the obliqui then support and compress them; and when the latter act, and the viscera are thereby protruded forwards, the recti in their turn resist and support them; and one object of the interruptions in these muscles would appear to be, to enable the recti to act the better as moderators of particular sections of the obliqui, and *vice versa* in respect to the latter upon the former; by means too of this association or connection between the lateral muscles and these transverse partitions, the influence of the recti and obliqui must be greatly and remotely extended; were the recti merely attached to the sternum and pubis, they could only compress the viscera and approximate their own attachments by flexing the spine, but as the internal oblique are intimately united to their tendinous sheaths and intersections, the recti can now act through these oblique muscles on the whole of the anterior and lateral margins of the pelvis; this apparently complex structure then in the recti, is clearly of essential service in the functions of all the abdominal muscles. Meckel maintains that these intersections are "incontestably" but incomplete repetitions of ribs in the abdominal walls, as the linea alba is analogous to the prolonged sternum of the crocodile, and the two oblique muscles to the two laminæ of intercostals, and the transversales to the triangulares sterni. The doctrine of analogy is, no doubt, highly interesting, and often most useful as being explanatory, but when a special structure exists for an obvious special purpose, there appears but little advantage in resorting to it. Anterior to the origin of the rectus is the following small muscle.

Pyramidalis is sometimes absent, it *arises* broad and fleshy from the symphysis pubis, and from the upper edge of the bone external to it; the internal fibres ascend vertically, the external obliquely inwards, and are *inserted* narrow and tendinous into the linea alba, midway between the umbilicus and

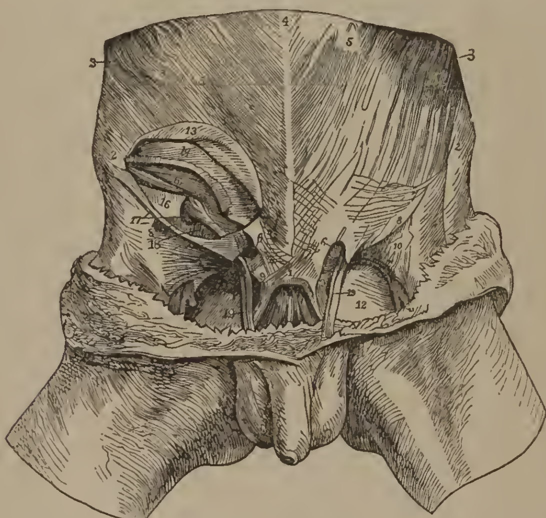
pubis. *Use*, it assists the rectus, and makes tense the linea alba; it is covered by the tendon of the external oblique, by the triangular ligament, and the conjoined tendons; it appears in some cases to be inclosed in a splitting of the latter; bony processes or ridges sometimes rise from the upper border of the pubes, in the line of these muscles, denoting a remote analogy to the supra-pubal bones and muscles in the marsupiata.

The group of muscles now described belongs to the class of voluntary muscles, with certain peculiarities; as locomotive agents, the will can excite and control them on both sides together, or on either singly; also in the acts of expiration and vomiting, defæcation and parturition, the will can influence them, although in each of these they occasionally act without even the consciousness of the individual, and thus afford remarkable examples of sympathy with different organs, the lungs and larynx, the stomach and intestines, the uterus and the bladder, sympathies which cannot be explained by any direct nervous communication, and must, therefore, depend on the excito-motor power of the nervous system. The combined actions of these muscles must be to diminish the cavity and to compress the viscera of the abdomen; in painful conditions of the peritoneum or its contents, we perceive the efforts that are made to keep these muscles in a relaxed state by bending the thighs, and approximating the pubes to the sternum, in this position. I think I have sometimes observed that a gentle action of the recti was maintained, as if to bear off all anterior weight or pressure from the tender parts within. By the simultaneous action of these muscles, the viscera are pressed backwards against the unyielding spine, upwards against the diaphragm which is thereby raised in an arched manner on either side, where it chiefly admits of this change, against the lungs, from which the air is expelled, and expiration occurs; also downwards into the pelvis, thereby pressing against the levator ani (the counterpart of the diaphragm), this then protrudes towards the perinæum, which becomes somewhat convex, and if the sphincters now assent, defæcation will result; thus the transverse and antero-posterior diameters are lessened, while the vertical axis of the abdomen is increased, and, if the contraction be moderate, the parts within suffer but little compression; should the diaphragm, however, and levator ani contract at the same time, as they always do when any violent muscular effort or strain is made, then the cavity is contracted in all directions, the viscera are subjected to strong and general compression, and then it is that some weak spot in the parietes give way, and a hernia protrudes: the surgical anatomy of the parts concerned in this disease shall next engage our attention.

Dissect off the transversalis muscle in a direction from the ilium towards the linea semilunaris, and the *fascia transversalis* will be exposed, covering the peritoneum; this fascia is connected on either side to the internal lip of the ilium and to the whole length of Poupart's ligament, as far as the pubis; thence it extends all over the abdomen, lining the transverse muscle, covering the peritoneum, and presenting different appearances and degrees of strength in different situations, aponeurotic in some, cellular in others. It consists, at least inferiorly, of two laminæ; the external or superficial is fibrous, and distinct, and strong in each inguinal region; it lines the muscle, and is closely united to its fasciculi; this is the true fascia transversalis: the epigastric vessels intervene between it and the deep, or cellular layer, which is attached to the peritoneum, and is, in fact, its subserous tissue; in the superior and lateral regions of the abdomen the fibrous tissue is scarcely discernible, and the whole fascia appears little more than fine connecting cellular tissue; but in each inguinal region the fibrous layer is distinctly aponeurotic, and the deep cellular layer, or tissue, is thick and abundant, allowing the peritoneum to be freely separated from the iliac and inguinal fossæ, filling up the angular interstices behind Poupart's ligament, also partially closing the femoral ring,

and then extending into the pelvis. It is not, perhaps, critically correct to consider the subserous tissue as a layer of transverse fascia, although it may be convenient to do so in anatomical description; this cellular lamina cannot be seen at present, but will be again alluded to in connection with the crural arch and femoral hernia: from Poupart's and Gimbernaut's ligament the fascia transversalis is prolonged upwards, even to the diaphragm, with the cellular coating of which it is continuous; externally to the psoas muscle and to the spine, internally to the rectus; to the border of which it adheres so closely as to appear to end abruptly; a thin lamina, however, extends behind to join that from the other side; immediately above the pubis this close connection to the edge of the rectus is very marked; it here also plainly separates into two laminæ, one strong and tense, adheres to the outer and anterior border of the muscle; the other, thin and weak, passes posterior to it: between the pubis and the crest of the ilium, and for about an inch and a half above the crural arch, this fascia is generally aponeurotic and firm, and claims particular attention; immediately external to the rectus it is inserted into the linea innominata of the pubis in common with Gimbernaut's ligament, but on a plane posterior to it; tracing it outwards, we observe it advancing a little forwards, and attached to the inner border of Poupart's ligament through its whole length, as far as the spine of the ilium, and beyond

Fig. 38.*



* The inguinal region in the male. 1. The symphysis pubis. 2. The anterior superior spinous process of the ilium. 3. 3. The external oblique muscles. 4. The linea alba. 5. 5. The linea semilunaris. 6. 6. The external abdominal rings. 7. The origin of the intercolumnar fibres. 8. Poupart's ligament extending from 2 to 9. The lower pillar of the abdominal ring. 10. The iliac portion of the fascia lata of the thigh. 11. The saphena vein. 12. The pubic portion of the fascia lata. 13 The tendon of the external oblique cut open, to show the parts that are situated behind it. 14. The internal oblique muscle, its lower edge is raised and turned up. 15. The transversalis muscle, its lower edge is also raised and turned up. 16. The fascia transversalis. 17. The internal abdominal ring, the fascia is strong external and inferior to it, but weak on the pubal side, being there strengthened by the transversalis tendon. 18. The internal epigastric artery and vein, situated behind the fascia transversalis, at first on the inner side, and afterwards behind the spermatic cord. 19. 19 The spermatic cord descending from the internal abdominal ring, along the inguinal canal, through the external abdominal ring, and down to the testicle.

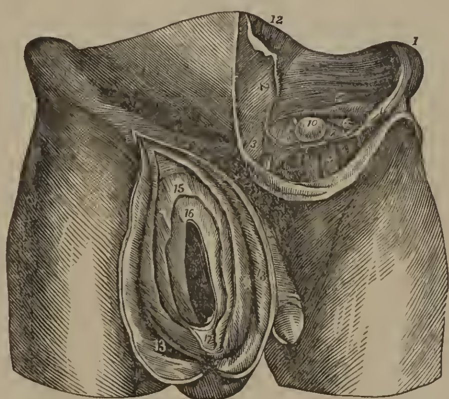
this to the crest of that bone; its connection to the ligament appears very intimate, and accounts for some writers describing the fascia as "arising from the reflected border of the crural arch;" this is not critically correct, for dissection will show a portion of it descending into the thigh behind this arch, through a space about two inches broad, in front of the crural ring, and of the femoral vessels; this process is named the "anterior sheath" of these vessels, and it can be traced as low as the junction of the saphena with the femoral vein, were it is lost in the general cellular sheath; for the present, this process requires no further notice; external to the iliac or femoral artery the fascia transversalis is most intimately attached to Poupart's ligament as far as the spine of the ilium; and through this extent it is also continuous posteriorly with the fascia iliaca, which is a strong membrane covering the psoas and iliac muscles, and will be more particularly noticed hereafter; a dense white line marks the amalgamation between these three structures, viz.: the transverse and iliac fasciæ, with Poupart's ligament; this line extends in a gentle curve from the femoral artery to the crest of the ilium; inclosed in its aponeurotic or seam-like texture are the internal circumflex ilii artery and veins; these vessels give additional firmness to this line, which acts as a tense connecting band, strengthening Poupart's ligament, and tying it down posteriorly close to the iliac muscle, so as to close completely that portion of the crural arch external to the artery, and effectually secure it against any protrusion from the abdomen. From Poupart's ligament to a short distance above the level of the lower border of the transverse muscle, this fascia is usually firm and resisting, and therefore it materially serves to strengthen the wall of the abdomen, and to compensate for the deficiency and weakness of the internal oblique and transverse muscles, which do not descend so low as the crural arch through the whole of this extent; this portion of the fascia is behind the spermatic cord; it is covered immediately behind the external ring by the conjoined tendons, and more externally by the folded fibres, and by the tendinous expansion of the transversalis muscle, and still more externally, for a short distance, the cord lies upon it, until it arrives at the superior, or internal ring, where occasionally a fasciculus of the transverse muscle intervenes; the spermatic cord, or the round ligament, always perforates this fascia about half or three-quarters of an inch above Poupart's ligament, and about an inch and a half or two inches from the tuberosity of the pubis; this perforation is called the *internal*, or *posterior abdominal ring*, and is situated about midway between the spine of the ilium and the symphisis pubis; it is not a distinct opening, for the fascia is prolonged in a tubular form for an indefinite distance, as one of the coverings of the cord, and, though fine, it can be traced even to the tunica vaginalis; this process is named the *infundibuliform fascia;* by gently drawing the cord towards the external ring it becomes very evident, and if this be now divided with a few circular touches of the knife, and pushed a little upwards, the internal, or superior, or posterior abdominal ring will become distinct; through this opening oblique inguinal hernia occurs, and it is in this situation that the neck of the sac suffers strangulation; about the eighth of an inch to its inner or pubal margin is placed the epigastric artery, usually with a vein on either side; these vessels are posterior to the fascia transversalis, but can generally be distinguished through it; a small hole may be made in it to expose them more distinctly; they may be considered practically, though not critically so, as forming the internal, or pubal boundary of the ring, while the transverse muscle borders it superiorly and externally; projecting through this opening we perceive the peritoneum covered by its subserous tissue, or the cellular layer of the fascia transversalis; from this projection, or bulging of the peritoneum (which will be more evident if we make gentle pressure on the abdomen above), a fine smooth fibrous process extends down along the cord; this is the remains of the tubular process of peritoneum

which, in the fœtus, led from the abdomen to the scrotum, and behind which, and enveloped by it, the testicle and cord were guided from their original situation in the abdomen to their final destination in the scrotum; this tube was at first a serous canal, communicating above with the cavity of the peritoneum, and below with that of the tunica vaginalis; shortly after the descent of the testis this tube becomes closed, its sides adhere, and in process of time it loses all its original serous character; it is named the tunica vaginalis of the cord, as it serves to inclose, in a sort of sheath, all its component parts, except the cremaster muscle, which is superficial to it. Inguinal hernia in the adult descends in front of this tissue, between it and the superadded coverings of the cord; in infancy, however, this tube is not always closed sufficiently early or completely, and then an inguinal hernia may descend within it down to the testis; such form of hernia is named congenital inguinal hernia. The interval between the internal and external abdominal rings is traversed in man by the spermatic cord, and is named the *inguinal*, or *spermatic canal*, to the anatomy of which the student should particularly attend, as the disease of *inguinal hernia* is situated here, in the treatment of which a correct knowledge of this region will be required. The *spermatic* or *inguinal canal* represents a sort of oblique, narrow groove, or gutter, the concave surface below, one wall, or side, in front, another behind, and, superiorly, a mere muscular interstice; it commences at the internal ring, and leads obliquely downwards, forwards, and inwards to the external, or inferior ring, where it terminates; this passage is bounded anteriorly by the skin and the two laminæ of the superficial fascia, by the tendon of the external oblique, and by the inferior fleshy margin of the internal oblique muscle; posteriorly, and from the internal to the external ring, by the transversalis fascia, covered sometimes by a few fibres of the transverse muscle, which are behind the cord, and next by the folded fibres and expanded tendon of this muscle, and lastly, by the conjoined tendons covered by the triangular ligament; inferiorly by the broad, grooved, or concave surface of Poupart's ligament and its reflected fibres proceeding to form its third insertion, or Gimbernaut's ligament; superiorly this space is closed by the apposition of its opposite sides; or rather it is occupied by the fleshy margin of the transverse muscle: as this muscle seldom descends below the upper border of the internal ring, it cannot be correctly said to form any of the anterior boundary of this space, though occasionally it has been so stated; not so, however, with the internal oblique, the fleshy margin of which is always anterior to this ring, and to the cord for some distance below it, whilst its tendon is posterior to it opposite the external ring; it is, perhaps, on this account, that some writers omit (I think incorrectly) this muscle from among the anterior boundaries of this canal. On the posterior, or abdominal wall of this inguinal channel, we perceive a triangular depression, defined internally by the edge of the rectus, externally by the epigastric vessels, inferiorly by Poupart's ligament; this depression is bounded posteriorly by the conjoined tendons and the triangular ligament in its two inner thirds, and in its outer third by the expansion of the transversalis tendon and fascia; the lower part of this depression is opposite the external ring, and through this, direct or ventro-inguinal hernia occurs. In the male the spermatic cord and cremaster muscle, and in the female the round ligament of the womb, pass through this canal, the obliquity, or valve-like structure of which serves to protect the abdomen against a protrusion of its contents. Inguinal hernia occurs more frequently in the male than in the female sex, in consequence of the spermatic cord and the inguinal rings in man being larger than the ligamentum teres, or these openings in the female; in the infant the inguinal canal is shorter, less oblique, the rings are more nearly opposite, owing to the narrow pelvis, and to the crural arch being short; hence if the same exciting causes were present at this age, hernia would be more frequent in its

occurrence than in the adult; I have, however, observed that the parietes are more muscular.

Inguinal hernia is either oblique or direct. *Oblique inguinal hernia* is the more common form; in this case the peritoneum, or hernial sac, with its contents, protrude through the internal ring along the anterior part of the spermatic vessels, carrying before it the surrounding cellular tissue and a prolongation of the fascia transversalis from the edges of the opening; the first is called the *fascia propria* of inguinal hernia, and the second the *fascia infundibuliform.* When the tumor has arrrived at the lower edge of the internal oblique it insinuates itself between the cremaster muscle and the vessels of the cord, along which it descends to the external ring, where it is in general delayed for some time; the form of this opening and the inter-columnar fascia preventing its free passage through it; as the sac, however, descends towards the scrotum, these inter-columnar fibres become closely united to the cremaster, and are gradually elongated on the surface of the tumor. If oblique inguinal hernia which has passed the external ring be carefully dissected, it will be found covered by the following parts; beneath the integuments is the superficial fascia, in general much thickened, and divisible into two or more laminæ; next is the inter-columnar fascia supporting the tumor, and attaching it towards the external ring; beneath this, and generally intimately united to it, is the cremaster muscle, the fibres of which are often, but not

Fig. 39.*



* This plate represents, on the left side, a small oblique inguinal hernia, making its appearance at the internal ring, on the outer side of the internal epigastric artery; and on the right side a scrotal hernia, with its coverings displayed by dissection.—(After Sir A. Cooper.) 1. The anterior superior spinous process of the ilium. 2. The tendon of the external oblique muscle reflected to show the inguinal canal. 3. The external, or superficial abdominal ring. 4. Poupart's ligament. 5. The internal oblique muscle, its lower margin is turned upwards to expose the hernial sac. 6. The lower edge of the transversalis muscle. 7. The fascia transversalis. 8. The femoral artery. 9. The femoral vein. 10. A hernia appearing at the internal abdominal ring midway between the anterior superior spine of the ilium and the symphysis pubis; a small portion of the internal epigastric artery is seen on its inner side. 11. 11. The spermatic cord seen emerging from the internal abdominal ring behind the hernia, and taking its course through the external ring into the scrotum. 12. The rectus muscle. 13. 13. The integuments reflected, to show the coverings of the hernia after it has reached the scrotum. 14. The fascia superficialis coming from the external abdominal ring, and forming the superficial investment of the hernia; at its upper part the transverse fibres of the external ring are seen. 15. The cremaster muscle thickened; it is seen descending under the margin of the external ring, and is lost upon the tunica vaginalis at 17. 16. The hernial sac covered by the fascia propria. 17. The testicle.

uniformly, found considerably thickened and strengthened; these two last-mentioned structures frequently form one capsule to the tumor; deeper than this is the infundibuliform process of the fascia transversalis, derived from the margins of the internal ring, and subjacent to this is the cellular, or internal layer of the fascia transversalis; this immediately covers the hernial sac, or the peritoneum, and may be named its fascia propria; beneath this the hernial sac, or the peritoneum, will be found, which also, in cases of old hernia, will be considerably thickened; on opening the hernial sac, its contents, either omentum or intestine, will be seen; these coverings are found to be extremely variable, being sometimes easy of separation, at others, condensed and united by adhesive inflammation into one homogeneous covering, in which it is impossible to recognize the different tissues and laminæ we have enumerated. The student should next attend to the situation of the epigastric vessels and their relation to the parts concerned in oblique inguinal hernia; these vessels are placed behind the fascia transversalis between it and the peritoneum, or rather between the fibrous and cellular laminæ of the fascia, and in general can be discerned through the latter; if not, a little dissection, as has been remarked before, will render them apparent; two veins usually accompany the artery, one on either side; sometimes there is but one epigastric vein, and that is on the pubal, or inner side of the artery. The *epigastric artery* arises from the external iliac, naar Poupart's ligament; it first descends a little forwards and inwards, then ascends towards the rectus muscle, immediately behind the fascia transversalis, and very near to the inner, or pubal side of the internal abdominal ring; in this course it forms the external boundary of that triangular depression on the posterior surface of the inguinal channel, of which the rectus is the inner border, and Poupart's ligament the base; this surface, as was mentioned before, is bounded posteriorly in its two internal thirds by the tendons of the oblique and transverse muscles, and in its external third by the fascia transversalis; it is through some part of this space, internal to this artery, that direct inguinal hernia occurs; nearly parallel to this vessel is the ligamentous cord-like remains of the umbilical or hypogastric artery, proceeding towards the umbilicus; this cannot be distinctly seen at present; it will be found hereafter, that this substance, by projecting inwards, or towards the cavity of the abdomen, causes the peritoneum to bulge on either side of it into two pouches, called the internal and external inguinal pouches; these are separated by this projecting cord, and when the viscera are forced, by the violent contraction of all the parietal muscles, into these pouches, there is a strong tendency to protrude them still more, and thus this conformation is very generally believed to favor the production of hernia; the internal abdominal ring corresponds to the lower part of the external inguinal pouch; and the triangular surface, just spoken of, behind the external ring, corresponds to the internal inguinal pouch. The obliterated hypogastric artery is not always parallel to the epigastric, but is sometimes a little internal to it, in which case a small pouch, or fossa of peritoneum, will exist between these, cut off by the epigastric artery from the large external inguinal pouch; this fact will be shown directly to possess some anatomical interest, as well as practical importance. In oblique inguinal hernia, particularly if of long standing, the neck of the sac is nearly in contact with the epigastric vessels, which thus bound it on its internal side; hence the rule of practice in performing the operation for the relief of strangulated oblique inguinal hernia, when the stricture is seated in the neck of the sac, is to direct the edge of the knife, or bistoury, upwards, or upwards and outwards. *Direct*, or *ventro-inguinal hernia* protrudes directly through the external ring, without descending along the spermatic channel. The occurrence of this species is in a great degree guarded against by the fascia transversalis, and by the expansion of the tendon of the transverse muscle, also by the conjoined tendons which lie

immediately behind the external ring; the contracted form of the base of this opening, together with the intercolumnar fascia, the edge of the rectus, the triangular ligament, and the spermatic cord, may be all enumerated as additional protections to this part of the abdomen. In this species of hernia the sac will be found covered by the integuments, superficial and intercolumnar fasciæ, also by an aponeurosis derived from the conjoined tendons, and from the fascia transversalis, which the tumor has pushed before it, though in some instances the latter has been found to have burst through these structures; the sac will be also covered by the usual cellular capsule; it is not covered by the cremaster, and in general it descends along the inner and anterior side of the cord, that is, the cord will be found external and inferior or posterior to it; but in some few cases the cord has been found passing across the neck of the sac, that is, anterior to it; the sac is seldom or never, however, found between the cremaster muscle and the spermatic vessels, except occasionally, in one particular form of which I shall speak directly. The epigastric vessels lie to the iliac, or outer side of the neck of the sac; in dividing the latter, therefore, in case this operation be required during life, the edge of the knife should be directed upwards, or upwards and inwards. It is safer, as a general rule, to divide the stricture directly upwards in all forms of inguinal hernia, because it is often extremely difficult, and in some cases even impossible to determine, during an operation, the exact species of the disease; thus when an oblique inguinal hernia has continued for a considerable length of time, the spermatic canal will be found altered in many respects from its natural condition; it will have become dilated and shortened, and the abdominal rings expanded and approximated, so as to render it difficult to distinguish it from a direct inguinal hernia; and again, the direct hernia sometimes protrudes more externally, that is, close to the pubal side of the epigastric vein and artery, in which case the tumor may be delayed for some time in the canal, and must descend with some obliquity to reach the external ring: direct, or ventro-inguinal hernia, therefore, appears under two different forms; one, which is the more common, protrudes directly through the external ring, on the outer edge of the rectus, this is named *internal*, or *inferior direct hernia;* the other, which is less frequent, protrudes close to the pubal side of the epigastric vessels, external to the obliterated hypogastric artery, and in the small peritoneal pouch between these; this is named *superior*, or *external direct hernia;* both forms correspond in not protruding through the internal ring, as the oblique hernia does, but through the posterior wall of the inguinal canal, and in some parts of the triangular depression before alluded to; both also are internal, or on the pubic side of the epigastric vessels; the internal, or inferior, is between the hypogastric artery and the rectus; and the superior, or external, is between the hypogastric and epigastric arteries; the superior may be retained for a longer or shorter period in the canal, as the oblique often is, and in its course downwards may pass between the cremaster muscle and the cord, so as to be covered by the former; hence, then, the obliquity of the tumor will render it impossible, before operation or dissection, to discriminate this superior, or external direct hernia from the ordinary oblique, and even when the parts are partially exposed during life, the presence of the cremaster will render the diagnosis equally difficult and uncertain. To divide the stricture directly upwards, is, therefore, the best general rule to adopt, when it exists at the neck of the sac, which is found to be its most frequent situation; if it be in any of the more superficial tissues, the direction of the division is comparatively unimportant; great caution, however, is to be observed in all the steps of such an operation, as deviations from the common arrangements are not uncommon; thus the sac, in oblique hernia, sometimes separates the vessels of the cord from each other, and instead of their being placed posterior to it, the vas deferens, or the spermatic artery, or a plexus

of veins, may be unexpectedly found crossing, or coursing along the tumor; in the direct species, also, the whole cord has been found passing in front of the sac, and in old herniæ of large size, whether oblique or direct, parts often undergo strange alterations, in structure as well as in position; it is of importance also to bear in mind, that when a stricture on a hernia is placed in the neck of the sac, a division to a very short extent only is required (the mere pressure of the edge of the bistoury against it sometimes suffices); and this is fortunate, for when the neck has become very large it will be found to have formed, not only a close lateral attachment to the epigastric artery and veins, but by the approximation and dilatation of the rings, and shortening of the canal, it will often have become partially encircled by those vessels, so that a too extensive incision directly upwards may divide them; no doubt, should such an accident occur, a little dissection will enable the operator to expose and tie them; but for obvious reasons, in this case especially, prevention is better than cure. The next point to be attended to, in connection with the anatomy of inguinal hernia, is the disposition of the peritoneum in this region, and to which we have already partially alluded: divide the transverse fascia from the rectus to the crest of the ilium, carefully separate it and turn it down towards the thigh; a layer of cellular membrane, containing more or less adipose substance, is now exposed, covering the peritoneum; this layer some consider (as was before mentioned) the deep layer of the transverse fascia, but it is a totally different structure from it, at least in this particular region; it is mere sub-peritoneal cellular tissue, it increases in thickness as it descends to Poupart's ligament, from which it is reflected backwards and upwards on the front of the external iliac vessels, and on the back part of the peritoneum towards the spine; internally it descends into the pelvis; as it passes from Poupart's ligament towards that region it closes the femoral ring beneath this ligament on the inner side of the femoral vein; in that locality it becomes much thickened, and is commonly named the *crural septum*, implying that it separates the thigh from the abdomen, or closes up the communicating passages between these, and as it must be pushed before a femoral hernia, and form an immediate covering to it, it is called its fascia propria; make a transverse incision through the peritoneum, from the umbilicus to the ilium, raise and hold tense the membrane, and look from above downwards into the cavity; from the umbilicus three projecting ridges are seen to descend, one in the centre (urachus) to the summit of the urinary bladder, and one on either side (obliterated umbilical, or hypogastric arteries), diverging towards each inguinal region, and then bending backwards towards the side of the pelvis; these lateral ridges are more prominent than the central one, and as each of these is covered by a duplicature of the peritoneum, they throw this membrane into three falciform processes, converging to the umbilicus, and separating below; by these three folds, four pouches are formed, two on each side; these are termed the right and left external and internal inguinal pouches; the external is very large and deep, and in corpulent persons, or in long continued constipation and distension of the bowels, is often very prominent through the parietes; this external pouch extends outwardly to the ilium, and is bounded internally by the hypogastric artery, to which the epigastric is nearly parallel, though often the latter is a little external to it; the internal ring is at the inner side and lower part of this pouch, and, of course, external to the falciform projection of the hypogastric artery; when the intestines in this pouch are subjected to much pressure from the muscles of the abdomen, this process would appear to resist their slipping inwards towards the pelvis, and thereby encourage the protrusion of the peritoneum and its contents through the internal ring; accordingly oblique inguinal hernia always leads out of this external inguinal pouch into the spermatic channel. The internal inguinal pouch is much smaller and never so deep as the exter-

nal; it is between the folds formed by the hypogastric artery externally and the urachus internally, and it corresponds to the external ring and posterior surface of the inguinal channel; it is this pouch which is generally protruded in direct, or ventro-inguinal hernia; when the hypogastric cord and epigastric artery are not parallel, but the latter at some distance external to the former, we shall find a small pouch, or fossa, between these; this might be named the middle inguinal pouch; it is separated from the internal by the hypogastric cord, and from the external (from which it is cut off) by the epigastric artery; it corresponds to that portion of the posterior wall of the spermatic channel which is almost wholly formed by the transversalis fascia; through this pouch that rare form of hernia, called superior, or external direct, or ventro-inguinal, protrudes.

In the dissection of these muscles several vessels and nerves are met with; they are of a small size, and, with few exceptions, of little practical importance; the superficial branches from the femoral artery, which are distributed chiefly to the integuments, to the superficial fascia, and to the external oblique muscle, have been already noticed; the five or six inferior intercostal and the lumbar arteries send branches forwards between the muscular laminæ to inosculate with the internal mammary and epigastric arteries; these two last-named vessels are chiefly distributed to the recti; inferiorly and laterally the ilio-lumbar and circumflex ilii arteries also assist in supplying the abdominal muscles; the origin and course of the mammary arteries have been already noticed; the intercostal and lumbar arise from the descending aorta, the ilio-lumbar from the internal iliac, and the epigastric and circumflex ilii from the external iliac.

The Epigastric *arises* from the trunk a little distance above Poupart's ligament, it first descends a little forwards and inwards, with a curve concave upwards, convex downwards, it then ascends obliquely, between the fascia transversalis and the peritoneum, behind the spermatic cord, or the round ligament, and at a little distance from the inner side of the superior abdominal ring; the vas deferens appears to bend round it externally, and then passes posterior to it in its course to the pelvis; this artery, therefore, ascends behind the inguinal channel, and of course between the two rings, but much nearer to the internal, or superior, than to the external, or inferior; oblique inguinal hernia commences on its outer side and descends anterior to it; direct hernia occurs internal to it, or between it and the rectus muscle; between the pubis and umbilicus it perforates the thin fascia transversalis, enters the sheath of the rectus just below its posterior deficiency, ascends at first posterior to the muscle, but near the umbilicus it enters its substance and anastomoses with the internal mammary, the abdominal branch of which enters the sheath of the rectus above the posterior deficiency in it, just beneath the cartilage of the seventh rib, and descends to the first or second linea transversa, then enters the muscle; shortly after its origin the epigastric sends off its internal branches, which pass behind Poupart's ligament and the pubes, to anastomose with the opposite artery, and to communicate in general very freely with the obturator; when this latter communication is much developed, and at the same time the pelvic origin of the obturator diminished or wanting, then the latter vessel is said to arise from the epigastric, and this very frequently occurs: near the internal ring the epigastric gives off one or two spermatic branches, which are chiefly distributed to the cremaster muscle and other coverings of the cord; before its termination in the rectus, it gives off external branches to the lateral muscles of the abdomen: its accompanying vein or veins open into the external iliac vein, near Poupart's ligament.

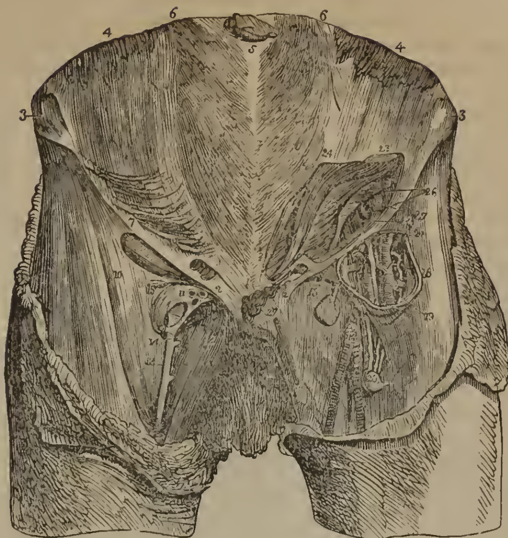
The Circumflex Ilii Artery *arises* opposite and near to the epigastric, it passes outwards and upwards towards the spine of the ilium, parallel to but deeper than Poupart's ligament, and inclosed in a strong fibrous canal already

described; near the ilium it pierces this and runs for a short way beneath the transverse muscle, and about the middle of the crest of the ilium it passes through this muscle and then ramifies between it and the internal oblique, sending some branches forwards to meet those from the epigastric, and continues itself upwards and backwards parallel to the iliac crest, and anastomoses freely with the ilio-lumbar artery from the internal iliac; it also sends several branches into the iliacus muscle, which anastomose in a similar manner; its trunk is accompanied by one or two veins which pass across the external iliac artery and join the iliac vein.—See *Vascular System.*

The nerves in the anterior and lateral abdominal walls are derived from the five or six lower intercostals and from the lumbar plexus; the intercostal branches extend forwards between the internal oblique and transversalis to the sheath of the rectus, perforate this and enter the muscle; each then divides into two branches at least, one for the muscle, the other, accompanied by a small artery, pierces the muscle and its anterior sheath near the linea alba and becomes cutaneous; the last dorsal runs downwards and forwards, and sends off a large cutaneous branch which pierces the two obliqui and descends over the crest of the ilium, and is distributed to the integuments over the glutæi. The branches of the lumbar plexus are only two or three in number, are of great length, and take an oblique course downwards and forwards towards the inguinal region, and are partly muscular, but principally cutaneous or superficial; the first is named by some, *superior musculo-cutaneous,* by others *ilio-inguinal,* or *scrotal;* it is derived from the first lumbar, passes through the psoas, and runs obliquely downwards and outwards in the sub-peritoneal cellular tissue; at the crest of the ilium it divides into an abdominal and a cutaneous branch; the first passes, similarly to the intercostal branches, between the oblique and transverse, to the rectus; the cutaneous branch proceeds as far as the anterior superior spine of the ilium, then proceeds parallel to Poupart's ligament and joins the spermatic cord, or round ligament, accompanies it through the canal, and is finally distributed to the integument of the pubes and groin. The next abdominal branch of the lumbar plexus, or *smaller musculo-cutaneous,* runs like the last as far as the spine of the ilium, communicates with it, accompanies the cord, and is lost in the inguinal and scrotal integuments.—See *Nervous System.*

In connection with inguinal hernia, the student may next study the anatomy of the groin in reference to *femoral* or *crural hernia,* or he may postpone this dissection until the contents of the abdomen have been examined and removed; we shall, however, here subjoin the description of the parts concerned in this disease. Remove the integuments from the anterior part of the upper third of the thigh; the superficial fascia will be seen descending over Poupart's ligament to invest the lower extremity; in the groin this fascia is of very variable structure, sometimes it is very thick, and may be divided into several layers, which are separated by lymphatic glands and by the superficial inguinal vessels; it may be easily raised from the fascia lata on the outer and inner sides of the thigh, but in the middle of the groin and about an inch below Poupart's ligament they are almost inseparably joined; when the superficial fascia shall have been dissected off the forepart of the thigh, we shall see several lymphatic glands, the saphena vein, and some small blood-vessels, lying on the fascia lata; the form and boundaries of the *inguinal region* also may then be more distinctly seen; the term *crural* is sometimes applied to this space, and that of inguinal to the smaller region above Poupart's ligament; I prefer naming the latter spermatic, and the former inguinal, or superior crural. The inguinal region is triangular, the base is Poupart's ligament; the apex is, inferiorly, formed by the meeting of the sartorius and adductor muscles, at the lower part of the upper third of the thigh; the external side is very prominent, and consists of the sartorius, iliacus, rectus, and other

Fig. 40.*



muscles, all covered by the fascia lata; the internal, or pubic side, is flat and on a plane posterior to the iliac; it is formed by the pectinæus and adductor muscles, also covered by the fascia lata. The *inguinal lymphatic glands* are irregular in number and size; they are in general about twelve in number, and may be divided into a superficial and a deep set; the former are the more numerous, and may be arranged, from their situation, into the superior and inferior; the superior are small, four or five in number, lie parallel to Poupart's ligament, some above, others below it: the inferior are two or three in number, larger than the former, and placed perpendicularly, or parallel to the saphena vein; in general one lies behind this vessel, near its termination, and sometimes so low down as the middle of the thigh; the *deep inguinal glands* are beneath the fascia lata, are three or four in number, and are closely connected to the sheath of the femoral vessels, chiefly to its inner side; in general one occupies the femoral ring; the inguinal glands are usually more developed in the young than in the old; their number is very uncertain and generally in an inverse ratio to their size, as if in some cases one gland was subdivided into several, and in others several united into one.

The *saphena vein* is the principal cutaneous vein of the lower extremity; it

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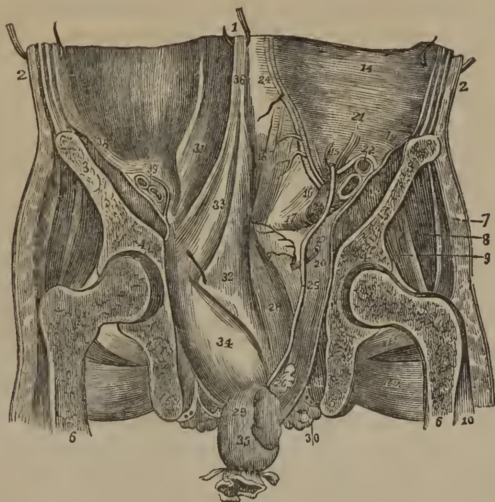
* The abdominal rings and crural arch in the female. 1. The symphysis pubis. 2. 2. The tuberosity or spine of the pubis. 3. The anterior superior spinous process of the ilium. 4. 4. The external oblique muscles. 5. The linea alba. 6. The linea semilunaris. 7. Poupart's ligament or the crural arch. 8. The intercolumnar fibres. 9. The external abdominal ring. 10. The iliac portion of the fascia lata. 11. The cribriform portion. 12. The pubic portion of the fascia lata. 13. The internal or greater saphena vein. 14. Burn's ligament. 15. Hey's ligament. 16. The femoral sheath cut open. 17. The femoral artery. 18. The femoral vein, the course of femoral hernia is on the inner side of the vein. 19. Absorbent vessels within the sheath 20. 20. Absorbent glands. 21. The internal circumflex ilii artery. 22. The internal epigastric artery, seen through the fascia transversalis. 23. The external oblique divided and raised. 24. The internal oblique muscle turned upwards. 25. The edge of the transversalis muscle turned upwards 26. The fascia transversalis, passing up behind the transversalis muscle. 27. 27. The round ligament of the uterus, descending through the internal abdominal ring, in the inguinal canal, above Poupart's ligament, and through the external abdominal ring, to be lost in the fat on the pubis.

will be seen in a future dissection to arise from the dorsum and inner side of the foot, and to ascend in front of the inner ankle along the inner side of the leg, and passing behind the inner condyle of the femur it continues to ascend along the inner and anterior part of the thigh to within about an inch and a half of Poupart's ligament, where it passes through an opening in the fascia lata (the saphenic opening), and joins the femoral vein about an inch or an inch and a half below the crural arch. The *saphenic opening* in the fascia lata will be very distinctly seen if the vein be divided on the thigh and raised towards Poupart's ligament, it presents a well-marked semilunar edge (Burn's ligament), the concavity looking upwards; this edge, though apparently sharp, yet if carefully examined, will be found reflected backwards on the sheath of the femoral vessels: remove the superficial inguinal glands, clean the surface of the fascia lata, to the connections of which in this region the student should next attend.

The *fascia lata* may be observed to be united to the spine of the ilium, to the whole length of Poupart's ligament, also to the linea innominata and spine of the pubis; it covers the muscles on either side of the groin, and the vessels in the middle: for the purpose of more particular examination, it may be divided in this region into three portions, the internal, or pubic, or pectineal portion, the external, or iliac, and the middle, or cribriform; the *internal* or *pubic portion* covers the pectinæus, gracilis, and adductor muscles, and is inserted internally into the ramus of the ischium and pubis; superiorly into the linea innominata or ileo-pectinea, anterior to Gimbernaut's ligament; externally it passes behind the sheath of the femoral vessels, and at the edge of the psoas tendon divides into two laminæ, one passes beneath that tendon, and is attached to the capsular ligament of the hip-joint; the other passes that tendon and is continued into the deep surface of the fascia iliaca. The *middle* portion of the fascia lata is very thin, and has been termed the *cribriform fascia:* this extends from the saphena vein to Poupart's ligament, and is connected on either side to the pubic and iliac portions of the fascia lata. The cribriform fascia is limited to a small extent, it covers the femoral vessels, adheres intimately to their sheath, and is perforated by the lymphatic vessels passing to the deep lymphatic glands; this portion of the fascia lata is more closely connected than any other to the superficial fascia; indeed in structure it resembles the latter more than the former, nor are all its fibres directly continued from those of the fascia lata; some have, therefore, considered the cribriform fascia as a deep lamina of the superficial; in many cases, however, it has an aponeurotic structure, and appears to be clearly derived from the iliac portion, and inserted into the pubic portion of the fascia lata; it presents much variety in this respect. The *external* or *iliac portion* of the fascia lata is very dense and strong, it is continued from the external surface of the thigh, and is intimately attached superiorly to the spine of the ilium, and to Poupart's ligament; and, uniting with the cribriform fascia, is continued in front of the femoral vessels, along with the inferior or reflected fibres of Poupart's ligament, and is inserted along with these into the linea innominata, thus assisting to form the external part of the base of Gimbernaut's ligament. If the cribriform fascia be removed along with the superficial fascia, then the iliac portion of the fascia lata will present the appearance of a *crescentic* or *falciform process*, extending across the femoral vessels, the concavity looking downwards and inwards; the inferior cornu joins the external cornu of the saphenic opening, and the superior cornu (Hey's ligament) is inserted, along with the reflected fibres of Poupart's ligament, or Gimbernaut's ligament, into the linea innominata, on the internal border of the crural ring; although this crescentic process appears to present a defined edge, yet if the latter be examined closely, it will be found reflected backwards on the sheath of the vessels, and on the muscles external to them, in the same manner as the

apparent edge at the lower part of the saphenic opening, beneath the saphena vein. When the thigh is extended and rotated outwards, this portion of the fascia lata will be found very tense, particularly the superior cornu of this falciform process, and if the limb be put into the opposite position, it will become relaxed, hence, then, in performing the taxis for the reduction of femoral hernia, the thigh should be flexed, adducted, and rotated inwards; thus this process of the fascia lata will be relaxed, and the crural ring more easily enlarged, for it is obvious that these fibres bound this opening anteriorly and internally, together with the reflected fibres of Poupart's ligament: there

Fig. 41.*



* A vertical section passing transversely through the lower part of the abdomen, and through the iliac bones, hip-joints, femora, and ischia. This plate represents the peritoneum lining the inferior portion of the anterior wall of the abdomen, the posterior wall of the abdomen and pelvis having been removed. On the right side the peritoneum has been detached, and drawn over to the left side, in order to expose the parts upon which it was applied. 1. A horizontal section of the anterior wall of the abdomen a little below the umbilicus. 2. 2. A vertical section of the lateral walls, including the external oblique, internal oblique, and transversalis muscles. 3. 3. A section of the iliac bones. 4. 4. Section of the acetabula. 5. Section of the tuber ischii. 6. Section of the femur. 7. Section of the glutæus maximus. 8. Of the glutæus medius. 9. Of the glutæus minimus. 10. Section of the vastus externus. 11. The external obturator muscle. 12. Part of the adductor magnus. 13. Section of the psoas and iliac muscles. 14. The fascia transversalis exposed by the removal of the peritoneum. 15. The internal abdominal ring. 16. The posterior wall of the inguinal canal. 17. Gimbernaut's ligament. 18. The posterior surface of the rectus muscle. 19. The iliac fascia, covering the iliac and psoas muscles. 20. The pelvic fascia. 21. The spermatic vessels divided just above their entrance into the inguinal canal. 22. The divided extremity of the external iliac artery. 23. The external iliac vein. 24. The internal epigastric artery and vein. 25. The vas deferens. 26. The vesicula seminalis of right side. 27. The obturator artery. 28. Part of the posterior surface of the bladder deprived of its peritoneal coat. 29. Section of the levator ani muscle. 30. Section of the internal pudic artery and vein. 31. Section of the internal obturator muscle. 32. External surface of the peritoneum, detached from part of the posterior surface of the bladder. 33. The peritoneum passing from the anterior wall of the abdomen to the summit and posterior surface of the bladder. 34. The peritoneum covering the posterior surface of the bladder. 35. Its continuation covering the anterior surface of the rectum. 36. Elevated fold of peritoneum, formed by the projection of the urachus and left umbilical artery. 37. External inguinal pouch. 38. Peritoneum, descending from the lateral wall of the abdomen over the internal iliac muscle, over 39. The external iliac artery and vein, into the cavity of the pelvis.

can, I conceive, be little doubt but that the upper and internal part of this falciform process is often concerned in forming the strangulation on femoral hernia. The close connection between Poupart's ligament and this portion of the fascia lata imparts considerable strength to this region, and draws this ligament downwards and backwards, so as to strengthen and assist in closing the external portion of the crural arch.

Next direct your attention to the internal surface of the crural arch, and to the connection between it and the deep fasciæ of the abdomen, viz. the transversalis and iliaca: first cut across the cord or round ligament, next divide the fascia transversalis from the spine of the ilium towards the rectus muscle, and dissect it down from the peritoneum, then, in the same direction, carefully separate from the latter the cellular layer which is attached to it; finally, push upwards, and secure in that position, the peritoneum with the contained viscera; the loose connecting cellular tissue in the iliac fossa readily admits of this separation; the first object now to be attended to is the detached lamina of cellular membrane which was interposed between the peritoneum and the fascia transversalis, and to which it is difficult to apply a name at once appropriate and unobjectionable. Some have called it the deep layer of the fascia transversalis; this, however, is incorrect, as it is of a totally different tissue, and is separated from it by bloodvessels, and has also a considerably greater extent; others have named it the subperitoneal or subserous cellular tissue, which it really is; this name, however, does not seem very appropriately applied to a structure which is to be examined detached from, and unconnected to that membrane; the term crural septum has also been applied to it, and to a certain extent correctly, for it forms a partition between the thigh and the iliac region of the abdomen; it has also been designated as the *fascia propria*, because in herniæ, whether inguinal or crural, this membrane must be protruded before the peritoneal sac, to which, therefore, it forms an immediate proper covering; under this title, then, we shall examine it, admitting, however, that this name is very open to criticism, it is in fact applying to a natural or normal structure a name derived from its unnatural or abnormal state; superiorly, then, this membrane is fine and delicate, merely serving as a connecting medium to the peritoneum; inferiorly it is increased in thickness, is laminated, and contains more or less adipose substance, and is separated from the fascia transversalis by the epigastric vessels; it lines Poupart's ligament, and rounds off the angle, by filling up the interstices, between it and the iliac vessels as they descend behind it; from this ligament the fascia propria is reflected upwards and backwards, externally over the iliac fascia, in the middle over the external iliac artery and vein, and internally it passes across the femoral ring towards the cavity of the pelvis; in the first or external portion it serves as a loose and cellular connection between the iliac fascia and the peritoneum, as also between the former and the cœcum intestine on the right side, and the sigmoid flexure of the colon on the left; in its middle portion, that is, in its inflection on the forepart of the iliac vessels, it is thin but firm and strong, and adheres on either side of them to the iliac fascia, which is behind these vessels, it thereby retains these in their position along the margin of the pelvis, and binds the vein and artery so closely together, that in the operation of passing a ligature around the latter, much difficulty has been experienced in separating these vessels; this difficulty, however, is easily surmounted by first making a small opening in this fascia and then tearing it to the extent required; internal to these vessels, and close to Poupart's ligament and the pubis, the internal portion of this fascia becomes very thick, passes across the femoral ring, and is depressed into it, so as to present a concavity above; this portion is often strengthened by aponeurotic fibres traversing it from the fascia transversalis in front to the fascia iliaca behind, that is, from the anterior to the posterior

part of the sheath of the vessels, and of the crural ring; this is the proper crural septum, it often contains a lymphatic gland; a cluster of lymphatic vessels always ascend through it; this serves to protect this portion of the crural arch against a hernia, and when the latter does occur, this is protruded before it, and as it is essentially cellular it yields to distension, and forms a regular investing capsule for the hernial sac, hence the term fascia propria; in its natural or normal state, then, the term crural septum is correctly applied; but in its abnormal condition, that is, when protruded before and around a hernia, its proper title is fascia propria; the uses, therefore, of this structure generally, are: first, to serve as a connecting medium to the peritoneum, in which its nutrient vessels may ramify; secondly, to add to the strength of the inferior or inguinal regions of the abdomen, by connecting the several structures more intimately together, and by filling up the angular interstices between substances of different form and consistence; thirdly, it retains the external iliac vessels in a fixed position; and lastly, and above all, it closes the femoral ring, and thereby affords much security against the occurrence of femoral hernia. This membrane may now be detached from this region, when we shall obtain a clear view of the internal surface of Poupart's ligament, of the parts which pass beneath it, and which fill the space or cavity of the crural arch, also of the attachments between Poupart's ligament, the fascia transversalis, and iliaca.

To the *fascia iliaca* we shall next pay some attention. This is a distinct, and, in some situations, a very strong aponeurosis, principally developed in the iliac region, and hence its name; it may be said to arise from the inner border of the entire crest of the ilium, and from Poupart's ligament external to the iliac artery; it expands over the iliac and psoas muscles, ascends on the latter as high as the diaphragm, and is attached to the ligamentum arcuatum above, and internally and laterally to the sides of the lumbar vertebræ, forming a series of tendinous arches over the lumbar arteries and the communicating branches between the sympathetic ganglions and the lumbar spinal nerves; each arch is opposite the groove on the side of the body of each vertebra; the last arch is very large and strong, extending from the last lumbar vertebra to the brim of the pelvis, the obturator and lumbo-sacral nerves pass beneath it; from the spinous process of the ilium to the iliac artery, this fascia is intimately united to Poupart's ligament by a strong tendinous attachment which is also common to the fascia transversalis; it is from this common tendinous structure, rather than from the ligament itself, that the lower fibres of the internal oblique and transverse muscles arise; a dense opaque line marks it distinctly, this incloses the internal circumflex ilii vessels; immediately on the outer side of the iliac artery the fascia separates from Poupart's ligament, presents a semilunar border towards the vessel, and then passing behind both the artery and vein and the crural ring, it descends into the thigh, forming the posterior part of the sheath of the femoral vessels, and lying in front of the psoas and iliac muscles, and of the anterior crural nerve; it adheres to these muscles, and internal to these to the pubis and to the capsule of the hip-joint, and becomes continuous with the pubic or pectineal portion of the fascia lata; from the iliac fossa it also passes inwards, behind the external iliac vessels, and is implanted into the thick fibrous covering of the lateral brim of the pelvis; the psoas parvus tendon (when present) is blended with it by a broad expansion over this line, the fibres of each, however, pursue a different direction. The iliac fascia is thin superiorly on the psoas, stronger on the iliacus, but does not adhere closely to either, cellular tissue, and sometimes adeps being interposed; its fibres are mostly transverse; the lumbar nerves are all posterior to it, except some small, perforating, abdominal, and inguinal branches; as it passes behind the femoral vessels, it separates the artery in front from the anterior crural nerve, which

is pressed down behind it into a groove between the psoas and iliac muscles. The iliac and transverse fasciæ are not only connected, or rather continuous with each other, throughout the whole distance between the iliac artery and the spine of the ilium, but even when they have separated and descended into the thigh, the transverse in front of the vessels and the iliac behind them, they are still connected by two vertical antero-posterior processes or septa, passing from the one fascia to the other; the first is between the artery and vein, the second is on the inner side of the vein, between it and the femoral ring and canal, and, in the case of a femoral hernia, will separate the tumor from that vessel, and prevent it compressing the latter. The iliac fascia serves, in the first place, as a firm covering to the psoas and iliac muscles; secondly, it affords considerable strength to the lower part of the abdomen, by its firm adhesion to Poupart's ligament, which it ties down so closely as to contract the crural arch, and effectually prevent any abdominal protrusion through it between the artery and the spine of the ilium; thirdly, it forms the posterior part of a smooth canal or sheath, for the passage of the femoral vessels and lymphatics, as the transversalis fascia forms the anterior; and lastly, by means of the connecting septa between these two, the sheath is retained of the necessary size only, and a strong resistance offered to its distension.

The attachments of the iliac fascia would appear capable of exerting some influence on the course of purulent collections, which have formed higher up in either the subserous, or peritoneal, or in the subaponeurotic cellular tissue; in either case it is a barrier, confining the fluid to the tissue in which it has been formed; in either case the fluid may descend towards the groin, but if it be in the subserous tissue, it will lie anterior to the great vessels, whereas it will be behind these if in the subaponeurotic, at least until it arrives in the thigh, where its further course may become modified by the connections of the fascia lata. The fascia transversalis has been already minutely described in the anatomy of inguinal hernia, we have now, therefore, only to observe its intimate attachment to the inner lip of the ilium and to Poupart's ligament from the spine of that bone, as far as the pubis, into the linea innominata of which it is inserted; here also it is inseparably joined to the conjoined tendons of the internal oblique and transverse muscles; as this fascia is passing anterior to the iliac or femoral vessels, a portion of it extends beneath Poupart's ligament, in front of these vessels, so as to form the *anterior part of their sheath*, as well as of the crural ring and crural canal; this process of the fascia transversalis soon becomes thin and indistinct, and is lost in the cribriform part of the fascia lata. The fascia transversalis and iliaca are not inaptly compared to a funnel, containing in the superior wide portion the peritoneum and its contents, and inclosing in the inferior narrow part, or pipe, the femoral vessels, and one or two lymphatic glands; of this funnel the fascia transversalis forms the anterior, and the fascia iliaca the posterior wall; these fasciæ may now be seen to be perfectly continuous with each other, between the vessels and the spine of the ilium, different names only being applied to different portions of one extensive aponeurosis; as the iliac and transverse fasciæ are continued one into the other, external to the iliac artery, the white line already noticed may be again observed.

The student should next consider how the space, commonly called the crural arch, is naturally filled; that portion of it between the spine of the ilium and the iliac or femoral artery is occupied by the psoas and iliac muscles, imbedded between which is the anterior crural nerve; on the pubic side of these muscles is the femoral artery, crossed at a right angle by the circumflex ilii vein; next to the artery is the femoral vein, and at a little distance to the pubal side of this vessel is Gimbernaut's ligament, which closes the internal part of this space; thus almost all the crural arch is filled, ex-

cept a small portion between the femoral vein and the third insertion of Poupart's or Gimbernaut's ligament; this space is the *femoral*, or *crural ring;* this is somewhat of a triangular form, the base, externally, is the femoral vein, the apex, internally, is Gimbernaut's ligament; it is bounded anteriorly by Poupart's ligament, and by the superior fibres, or cornu of the falciform process of the fascia lata, and posteriorly by the pubis, covered by the pectineal muscle, and by the pectineal portion of the fascia lata: the spermatic cord, or the ligamentum teres, lies on the anterior boundary of this opening, and above it, and still closer to it in front, is a small artery with its vein, branches from the epigastric vessels, which are passing inwards to the back part of the pubis; this artery generally inosculates with the obturator; this last-named artery, which is normally a branch of the internal iliac, very frequently arises from the epigastric, and then takes the course of the small anastomosing branch just mentioned, in front of the ring, and then dropping along its internal side into the pelvis; this very frequent anomaly in this vessel, we may regard as an hypertrophy, or excessive development of this anastomosis, and a proportional diminution in the size of the more regular artery; the epigastric vein and artery ascend obliquely inwards along the outer and upper angle of this opening, so that bloodvessels surround it on all sides, except posteriorly and internally, and even in the latter aspect also, when the obturator artery springs from the epigastric, as, in such a case, it may pass first in front, and then along its inner border, although occasionally it passes along the posterior border of the ring in its inward course to the pelvis. Gimbernaut's ligament prevents femoral hernia occurring internal to this space, which is the only part in the crural arch where a hernia can descend; and even here this accident is in a great degree guarded against, as a lymphatic gland generally occupies this situation, and the layer of condensed cellular membrane, already described as the crural septum, extends across the opening, and as this must be carried down before the hernial sac, so as to form a covering for it, it has been also named the *fascia propria;* this fascia, though often weak and indistinct in the natural and healthy state, becomes very thick and strong in cases of old femoral hernia. We should bear in mind that Gimbernaut's ligament is composed of the combined fibres of Poupart's ligament, and of the falciform process of the fascia lata; the latter fibres form its outer part. or base, that is, the portion nearest to the ring; this marginal base is somewhat crescentic, and is very similar to the semilunar border formed by the fascia iliaca on the outer side of the iliac, or femoral artery; so that the upper, or pelvic extremity, or opening of the crural sheath, presents a transversely elliptical figure; its anterior boundary is formed of fascia transversalis, Poupart's ligament, and the iliac portion of the fascia lata; its posterior boundary is formed of fascia iliaca, and the pubic portion of the fascia lata, covering the pubis, the pectineus, psoas, and iliac muscles, and the anterior crural nerve; the lateral angles, or commissures, are the two semilunar borders just alluded to. The entire of this opening may be considered as divided into three parts, or tubular processes, the external for the artery, the middle for the vein, and the internal as the crural ring, or canal. Crural hernia cannot occur external to the ring, as there the femoral vessels fill up the space, and strong partitions pass from the fascia transversalis to the fascia iliaca, one on the inner side of the vein, and another between it and the artery; these septa prevent the distension of the sheath; the fascia propria also rounds off the angle between the fascia transversalis, and the forepart of the vessels, and prevents a hernia occurring in front of the artery or vein; external to these vessels the crural arch is completely closed by the close connection between the fasciæ, lata, transversalis, and iliaca to Poupart's ligament, in front of the psoas and iliac muscles. *Femoral hernia*, then, can occur only at the femoral or crural ring; this disease is more

frequent in the female than in the male, the crural arch and ring being larger in the former than in the latter; femoral hernia descends through a sort of canal which commences at the crural ring, and ends at the saphenic opening in the fascia lata, narrowing as it descends ; this canal is but the internal portion of the crural, or femoral sheath, and is separated from the femoral vein by the internal septum before described; it is occupied by cellular tissue, lymphatic vessels, and very frequently by a gland ; it is closed above by the crural septum, or fascia propria, and below and in front by the cribriform fascia; although it descends as low as the entrance of the saphena into the femoral vein, it does not follow that when a crural hernia enters this canal, it should descend to this point before it comes forward ; some writers have affirmed that it does; my own experience, however, both in the living and the dead, induces me to doubt this, for I have found that the tumor had forced through the inner side of the canal at a point much higher than this. The hernial sac, in descending, carries before it the fascia propria, descends in the sheath of the vessels along the inner side of the vein, and may remain in this situation for a considerable time; as the tumor increases in size it bursts through the sheath, and either tears or dilates some opening in the cribriform fascia, and then turns forwards into the groin ; if the tumor increases still further, it is found to turn upwards over Poupart's ligament between the superficial and deep fasciæ of the abdomen, and to rest on the lower part of the tendon of the external oblique, generally in the direction of Poupart's ligament, and therefore there is often some difficulty in distinguishing between a femoral and an inguinal hernia; the form of the crural ring, the course of the superficial epigastric vessels, the close connection between the superficial and cribriform fasciæ, together with the frequent flexion of the limb, account for its ascending in this manner. If we dissect off the integuments from a femoral hernia of long standing, we shall find beneath them the superficial fasciæ, often so increased in thickness and vascularity as to present a compact and almost fleshy-like appearance; when this shall have been divided, the tumor can be brought down off the abdomen into the groin, and will be found covered by a dense and smooth capsule, which often presents a glossy appearance ; this is the fascia propria; in dissecting off this, it will in general be found to consist of several laminæ, which sometimes separate so easily and appear so distinct as to lead an inexperienced operator to suppose that the hernial sac itself is exposed. These, then, are the coverings of the sac, which is thus placed external or superficial to the fascia lata; the neck of the sac, however, it is to be recollected, lies deep within the sheath of the vessels, and is, therefore, covered by the fascia transversalis, by the superior cornu of the falciform process of the fascia lata, and by the reflected fibres of Poupart's ligament passing backwards and inwards to their pubic insertion. Let the student now review the dissection that has been made ; let him move the thigh in different directions, and he will remark that, when it is rotated inwards, Poupart's and Gimbernaut's ligaments, as well as the fascia lata, feel relaxed, and that the crural ring will become larger or more dilatable; let him also observe the relation of the femoral vein, the epigastric vessels, and the spermatic cord, or round ligament, to this opening; pass up the finger from the groin into the crural ring, and suppose that the stricture on femoral hernia was seated there, and that this opening required to be dilated, he will now perceive that this may be done with most safety, by directing the edge of the bistoury forwards and a little inwards, so as to divide the external edge or base of Gimbernaut's ligament, which edge is composed of the insertion of the superior cornu of the falciform process of the fascia lata. The stricture on femoral hernia may be, however, and I believe very often is, seated lower down than in the neck of the sac; it may be situated in that opening of the cribriform fascia through which the hernial sac has protruded ; in such

a case, the stricture may be easily divided by directing the edge of the knife directly inwards along the surface of the pectinæus muscle; or it may be caused by the superior cornu of the falciform process of the fascia lata twisting in from the forepart to the inner side of the tumor; the exact position of the stricture can only be known during the operation; in whatever tissue it is seated, it is only necessary to pass the bistoury guided by the tip of the finger beneath it, and, turning the edge towards it, to press gently against it; this will, I believe, in all cases, effect a safe division, and one sufficiently free for all practical purposes.*

SECTION II.

DISSECTION OF THE VISCERA OF THE ABDOMEN.

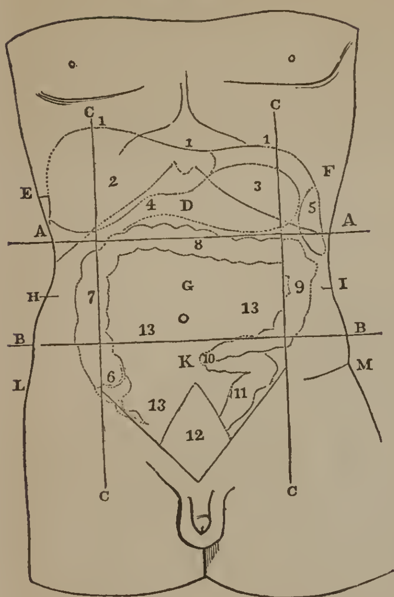
The abdomen is the largest cavity in the body; it is of an oval form; its capacity, and in some degree its figure, differ at different ages, and in different subjects; it is bounded superiorly by the diaphragm, anteriorly and laterally by the abdominal muscles, inferiorly by the true and false pelvis, and posteriorly by the lumbar vertebræ, the crura of the diaphragm, and the psoæ and quadrati lumborum muscles. Although the expression "cavity of the abdomen" is in common use, it is not correct, for during life there is no cavity, as the diaphragm and abdominal muscles, by their alternate action, keep up such a constant and uniform pressure on the viscera, that these and the parietes are always in perfect contact. The abdomen contains the peritoneum and the organs of digestion; the kidneys, renal capsules, and ureters; also the lacteals, or absorbent vessels, with their glands, and the thoracic duct, the sympathetic nerves, the aorta, vena cava, and the numerous branches

* The following measurements of the parts engaged in or referred to in the foregoing account of the anatomy of inguinal and femoral hernia have been extracted from Sir Astley Cooper's valuable work on hernia, and have been sanctioned by several other writers on the same subject: I have tested these very freqnently, and though I can bear testimony to their general accuracy, I must observe, I have found deviations to have occurred so frequently, and in cases where there was no *a priori* reason to expect such, that I do not consider these numbers as facts of much value or of any material practical importance.

		Male.	Female.
From the symp. pubis	to the ant. sup. spinous process of the ilium,	$5\frac{3}{4}$ in.	6 in.
" "	to the tuberosity of pubis, ...	$1\frac{1}{8}$	$1\frac{3}{8}$
" "	to the inner margin of ext. abdominal ring,	$0\frac{7}{8}$	1
" "	to the inner edge of internal abdom. ring, .	3	3
" "	to the middle of iliac artery, . . .	$3\frac{1}{8}$	$3\frac{3}{8}$
' "	to the middle of iliac vein, ...	$2\frac{5}{8}$	$2\frac{1}{4}$
' "	to the origin of epigastric artery, . . .	3	$3\frac{1}{4}$
" "	to the epig. art. on the inner edge of ext. abdom. ring.	$2\frac{3}{4}$	$2\frac{7}{8}$
" "	to the middle of lunated edge of fascia lata,	$3\frac{3}{4}$	$2\frac{3}{4}$
" "	to the middle of crural ring, . . .	$2\frac{1}{4}$	$2\frac{3}{8}$
From ant. edge of crural arch to saphena major vein, . . .		1	$1\frac{1}{4}$
From symp. pubis to centre of orifice of femoral hernial sac, . .		2	$2\frac{1}{8}$
From centre of orifice of do. to external iliac artery, . . .		1	$1\frac{1}{4}$
" "	to centre of ext. iliac vein. . .	$0\frac{3}{4}$	$0\frac{3}{4}$
" "	to origin of epigastric artery, . .	$0\frac{3}{4}$	1
" "	to inner edge of int. abdominal ring, .	1	$1\frac{1}{8}$
From tuberosity of pubis to centre of orifice of fem. hernial sac, .		1	$1\frac{1}{8}$

(*Anat. and Surg. Treatment of Abdom. Hernia, by* Sir A. Cooper, Bart., 2*nd Edit. by* C. A. Keys.)

Fig. 42.*



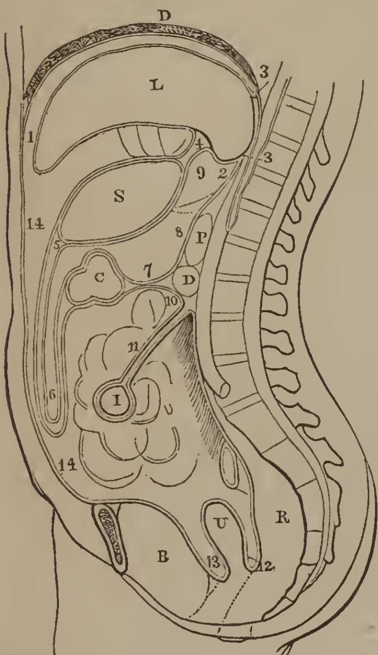
of these vessels. The abdomen is generally divided by writers into nine, but by some into twelve regions; by drawing two transverse lines, one between the extremities of the cartilages of the ninth or tenth ribs, and the other between the anterior superior spinous processes of the ossa ilii, we may define three regions; the *epigastric* above, the *umbilical* in the middle, and the *hypogastric* below; and then by drawing a vertical line on each side from the extremity of the eighth or ninth rib to the centre of Poupart's ligament, or a little external to it, we shall subdivide each of these regions into three parts; the three divisions of the epigastric region are the *epigastrium,* or scrobiculus cordis, in the centre, and the *right* and *left hypochondriac regions* on either side: the epigastrium is immediately below the ensiform cartilage, and the hypochondriac regions are covered by the false ribs; the lateral portions of the *umbilical* division are the *lumbar regions;* the middle of the hypogastric region is the *hypogastrium,* and the lateral portions are the *iliac regions;* the lower part of the hypogastrium is called by some the *pubic region,* and the lower part of each iliac division is called *inguinal region,* or more properly *spermatic* (the term inguinal being commonly applied to the upper and anterior part of the thigh), and contains the iliac vessels, and in the male the spermatic cord, and in the female the round ligament of the uterus. These divisions are somewhat arbitrary, there being no natural or fixed boundaries to these several compartments. The viscera, which constantly or occasionally occupy these several regions of the abdomen, will be seen when the peritonæal cavity has been opened, and with these the student should make himself familiar, as this knowledge may be of practical importance in cases of wounds penetrating this cavity, or in making an examination during life to detect any suspected organic disease. Dissect the abdominal muscles off the peritoneum; these can be easily separated laterally and inferiorly, but anteriorly, particularly near the umbilicus, it will often be found very difficult to detach the sheath of the rectus from this membrane, particularly in the adult or aged. The external surface of the perito-

* The anterior surface of the abdomen, divided into nine regions. The dotted lines indicate the situation of the different viscera. A. A. A horizontal line extending from one side of the base of the thorax to the other. B. B. Another horizontal line extending from one iliac crest to that of the opposite side. C. C. C. C. Two vertical lines passing on each side over the anterior superior spinous process of the ilium and extending to the base of the chest. D. The epigastrium or scrobiculus cordis. E. The right hypochondriac region. F. The left hypochondriac region. G. The umbilical region. H. The right lumbar region. I. The left lumbar region. K. The hypogastrium. L. The right iliac region. M. The left iliac region. 1. 1. 1. Line marking the upper surface of the diaphragm. 2. The liver. 3. The stomach. 4. The commencement of the duodenum. 5. The spleen. 6. The cæcum. 7. The ascending colon. 8. The transverse colon. 9. The descending colon. 10. The sigmoid flexure of the colon. 11. The commencement of the rectum. 12. The distended bladder. 13. 13. 13. Regions occupied by the small intestines, which have been omitted to avoid the confusion of lines.

neum, which is thus exposed, appears rough and cellular from its connection to the superincumbent muscles; three ligamentous cords are seen extending along it anteriorly and inferiorly, from the summit and sides of the urinary bladder towards the umbilicus; the central one of these is the remains of the urachus, and that on each side is the obliterated umbilical or hypogastric artery; anteriorly and superiorly we perceive another ligamentous substance, ascending from the umbilicus obliquely backwards, and to the right side; this is the remains of the umbilical vein; it is at first placed between the peritoneum and the muscles, but it soon sinks deep towards the liver, carrying around it a fold of peritoneum, named the suspensory, or falciform ligament of the liver, which will be seen when the peritoneum is opened; the epigastric vessels also may be observed ascending from each inguinal region, and branches of the internal mammary arteries descending on the surface of this membrane. Next open the peritoneum by an incision from the enciform cartilage to the umbilicus, and from this point carry another on each side obliquely downwards, to the spine of the ilium: on throwing down the inferior flap thus formed, we remark on its internal surface the projections of the three ligamentous cords, which were before noticed as ascending from the bladder to the umbilicus; we may also remark how the external of these cords, or the obliterated umbilical artery on each side, throws the lower part of the peritoneum into pouches, two on each side, the *external* and *internal inguinal pouches* or *fossæ;* the former lies between the ilium and the obliterated hypogastric vessel, the latter between this cord and the fundus of the bladder. The external pouch is large and very concave internally, and appears to protrude towards the inguinal canal: the existence of this pouch may conduce to the production of oblique inguinal as well as of femoral hernia: the internal pouch lies behind the external ring, and becomes protruded in direct or ventro-inguinal hernia; femoral hernia, also, sometimes, though rarely, protrudes this pouch. On raising the superior flap of the peritoneum, we see the remains of the umbilical vein, like a white thick cord, extending upwards and backwards to the edge of the liver, and carrying around and behind it the duplicature of the peritoneum, named the falciform ligament of the liver. When the peritoneum has been fully opened, we perceive its inner surface smooth and polished; this, as in all other serous membranes, is the seat of constant exhalation and absorption; filling its cavity we also see the numerous digestive organs; these, though apparently within this bag, are really behind it, and only protrude the posterior side of this large sac into its cavity; nothing is contained within the peritoneum but the serous fluid, which is constantly exhaled, for the purpose of lubricating its opposite sides. We also obtain a partial view of the following organs, which in general occupy the same situation during life as we perceive them now to hold. Filling the right hypochondrium is the liver, with the fundus of the gall bladder projecting a little below it. In the epigastric region we see a portion of the liver also. resting on the stomach, and below this the pylorus and the commencement of the duodenum; in the left hypochondrium lie the spleen and great extremity of the stomach; in the right and left lumbar regions we find the colon, ascending through the former, and descending through the latter, behind which is each kidney; the duodenum also partly occupies the right lumbar region; through the proper umbilical region the transverse colon runs, not fixed, however, in any particular part of it, and from this intestine we perceive the great omentum descending towards the lower part of the abdomen, presenting, however, very different appearances in different subjects; in some. being expanded over the small intestines so as nearly to conceal them; in others, being coiled up into a narrow fold, and often concealed in some recess between the surrounding viscera: the convolutions of the jejunum and ilium intestines occupy the lower part of the umbilical, and extend indifferently

into the hypogastric and iliac regions; the cæcum, or caput coli, is fixed in the right, and the sigmoid flexure of the colon in the left iliac fossa; the rectum and other pelvic viscera occupy the hypogastric regions, but will, of course, change their own situation, as well as that of the small intestines, according as they are contracted or distended. The student may next examine the anatomy of the *peritoneum;* this is the largest serous membrane in the body; it lines the abdominal muscles, and covers almost all the abdominal viscera; that portion which adheres to the parietes is called the *parietal,* and that covering the viscera the *visceral layer.* The peritoneum is a shut sac, and therefore, when opened, presents one continued surface, which may be traced throughout the whole extent without any interruption; it covers the viscera in such a manner as that they lie external, or posterior to it; the familiar example of the double nightcap on the head has been, not unaptly, adduced, to explain how the viscera may be covered by the peritoneum, and yet really lie beneath it or behind it. Let us now trace this membrane through its entire extent, commencing at the umbilicus; from the transverse incision that was made into it in this situation, we may perceive it to ascend on the internal surface of the transverse and recti muscles, as high as the margin of the thorax; then bending backwards it adheres to the inferior surface of the diaphragm, and continues very far back on this muscle, particularly in the left hypochondrium; from the diaphragm it is reflected on the left side, on the back part of the splenic vessels, and of the spleen, and is continued round the convex surface of this organ to the forepart of its vessels; more centrally it is reflected on the stomach, and on the liver on the right

Fig. 43.*



* A vertical section of the abdominal cavity and viscera, made along the median line to show the reflections of the peritoneum. D. The diaphragm. L. The liver. S. The stomach. C. The transverse colon. D. The inferior transverse duodenum. P. The pancreas. I. The small intestines. R. The rectum. B. The bladder. V. The uterus.

1. The layer of peritoneum lining the inferior surface of the diaphragm. 2. The posterior layer. 3. 3. The two layers passing to the posterior border of the liver, and forming the coronary ligament. 4. The lesser or gastro-hepatic omentum, the two layers passing from the transverse fissure of the liver to the lesser curvature of the stomach. 5. The two layers meeting at the great curvature of the stomach, descending to the lower part of the abdomen, then turning on themselves and ascending to the transverse arch of the colon, thus forming 6. The great omentum. 7. The transverse meso-colon. 8. The ascending layer of the transverse meso-colon, passing in front of the duodenum and pancreas to become continuous with the posterior layer, 2. 9. The foramen of Winslow. 10. The descending layer of the transverse meso-colon, passing downwards over the small intestines and their vessels, and returning along them to the spine, thus forming 11. The mesentery. 12. Reflection of peritoneum from the rectum to the back part of the vagina and uterus. 13. The continuation of this layer from the forepart of the uterus to the back of the bladder. 14. 14. The same layer passing from the superior fundus of the bladder to the abdominal muscles, on the inner surface of which it may be traced up to 1, on the inferior surface of the diaphragm.

side; it is also reflected on this last-named viscus by a distinct fold, the falciform, or suspensory ligament, which extends from the umbilicus, and from the abdominal muscles on the right side of the linea alba; this fold contains the ligamentous remains of the umbilical vein: as the peritoneum is reflected from the diaphragm on each side of these organs in the epigastric and hypochondriac regions, it forms folds, which to a certain extent, serve as ligaments; these will be noticed more particularly in the examination of the individual viscera. Having covered the organs in the upper division of the abdomen, it is continued downwards in the following manner; having invested both surfaces of the liver as far as its transverse fissure, it is conducted along and around the vessels of this gland towards the lesser curvature of the stomach; this fold, which thus surrounds the hepatic vessels, is called the lesser or the gastro-hepatic omentum; it is also sometimes, but incorrectly, named the capsule of Glisson; at the lesser arch of the stomach the two laminæ of this process separate to inclose this organ, the posterior layer giving a serous covering to its backpart, and the anterior layer to its forepart, on which it is continuous with that portion of peritoneum which has descended from the diaphragm, and with that which is also continued from the spleen to the stomach. The peritoneum having thus inclosed the stomach and its vessels between the two layers of the lesser omentum, we next observe that these laminæ having passed the great curvature of the stomach, touch each other, and being joined by the peritoneum from the splenic vessels and from the lower end of the spleen, descend, under the name of the gastro-colic or the great omentum, to the lower part of the abdomen; in general this descends lower on the left side than on the right; it then turns on itself, and ascends obliquely backwards to the arch of the colon, along the convex edge of which its laminæ separate to inclose this intestine and its vessels; along the concave edge of the colon these laminæ again unite, and, increasing in density, form that process which is called the transverse meso-colon, which passes backwards to the spine: opposite the duodenum this process separates into an ascending and descending layer; the inferior division of the duodenum lies between these; the ascending layer proceeds in front of the lower and middle divisions of the duodenum and of the pancreas, to the back part of the right lobe of the liver, where it becomes continuous with the peritonæal tunic of that viscus, and with the posterior layer of the lesser omentum, which is descending along the back part of the hepatic vessels. The descending layer of the transverse meso-colon expands into each lumbar region, in which it attaches the lumbar portions of the colon by a duplicature, very variable in extent, called the right and left lumbar meso-colon; in the centre the inferior layer of the transverse meso-colon adheres to the vertebral column, and to the great vessels which lie upon it, and is thence reflected forwards and downwards, over the small intestines and their vessels, and returns around these to the spine, thus forming a very important and remarkably folded, or plaited process, named the mesentery. From the inferior surface of the mesentery the peritoneum extends laterally into either iliac region, and in the middle it descends, in front of the sacro-vertebral prominence, and of the aorta and iliac vessels, into the pelvis; it serves to connect the cæcum and the vermiform appendix by a small mesentery in the right, and the sigmoid curve of the colon in the left iliac fossa; in the pelvis the peritoneum descends around the rectum, forming the process named the meso-rectum; opposite the lower third of the sacrum it is reflected, in the male, to the lower and back part of the bladder, forming two lateral semilunar folds, called the posterior ligaments of the bladder, between which it is depressed into a deep *cul de sac*, which descends to within a short distance of the prostate gland, and between the vesiculæ seminales. In the female it is reflected from the rectum to the upper and back part of the vagina, from which it ascends on the uterus, and forms on each

Fig. 44.*

side of this organ the broad ligament which is subdivided superiorly into three smal er folds, the anterior containing the round ligament, the middle the Fallopian tube, and the posterior the ovary; the peritoneum is then reflected from the forepart of the uterus to the back of the bladder, and forms a *cul de sac* between them; it has no connection to the lower fourth of the uterus, or to the vagina in front, though it covers the upper third of that canal behind; it then ascends, in either sex, along the posterior surface and sides of the bladder to its superior fundus; its extent on this organ is very variable, according as the latter is empty or distended; when it is contracted the peritoneum descends behind the pubis, but when distended it rises into the abdomen, pushing the peritoneum above it, and comes into cellular contact with the lower portion of the recti; from the bladder and from the iliac fossæ it is continued to the abdominal muscles, and may then be traced on the inner surface of the recti and transversi up to the umbilicus, where the sac was opened; between the pubis and this point it is raised by the ligamentous remains of the urachus and umbilical arteries into three falciform folds, whereby the four inguinal pouches are formed. Although the perito-

* A transverse section of the abdomen, showing the manner in which the peritoneum forms the mesentery, and covers the intestines without inclosing them in its cavity; the section passes through the body of the last dorsal vertebra obliquely downwards and forwards to a little below the umbilicus. Nearly the entire of the small intestines has been removed. 1. 1. Sections of the recti muscles of the abdomen. 2. A section of the external oblique, internal oblique, and transversalis muscles. 3. Section of the lumbar mass of muscles. 4. Spinous process of twelfth dorsal vertebra. 5. The body of the twelfth dorsal vertebra. 6. The twelfth rib. 7. Transverse section of the kidney. 8. The inferior vena cava. 9. The abdominal aorta. 10. The right or ascending colon cut transversely. 11. The cæcum and appendix vermiformis, as seen from above. 12. The ileum cut transversely. 13. Its termination in the cæcum. 14. The descending colon at its sigmoid flexure divided transversely. 15. The upper part of the rectum. 16. The superior fundus of the bladder, covered by the peritoneum. 17. The urachus raising up the peritoneum in the median line, as it passes to the umbilicus. 18. 18. 18. The peritoneum lining the anterior and lateral walls of the abdomen. 19. The peritoneum leaving the abdominal wall to envelope the left lumbar colon. 20. The peritoneum returning to the abdominal wall, thus forming 21. The left lumbar meso-colon. 22. The continuation of the same layer of peritoneum passing in front of the left kidney, renal vessels, abdominal aorta, and inferior cava. 23. The peritoneum leaving the great vessels, enveloping the ileum 24. and returning to the spine, 25. thus forming 26. The mesentery. 27. The peritoneum passing in front of the right kidney to the lateral wall of the abdomen. 28. The same layer leaving the lateral wall to envelope the right lumbar colon. 29. The peritoneum leaving the colon to reach the lateral wall, thus forming 30. The right lumbar meso-colon. From this point the peritoneum may be traced along the internal surface of the lateral wall to 18. where its description commenced.

neum has been thus traced as one uninterrupted surface, a sac without an opening, yet there is an exception to this statement; in the female pelvis the serous and mucous membranes are continued into one another through the open fimbriated extremities of the Fallopian tubes; this, which is the only exception in the human body to the perfectly closed condition of serous membranes, is somewhat analogous to the lateral anal openings in the abdomen of many fish, whereby the peritonæal cavity communicates by an oblique passage on either side with the surface of the body; in the human female, however, these fimbriated extremities are probably closed at all times, except when in contact with, or adhering to the ovaries; if such be the case, the serous membrane is still a shut sac, and the exception is more an apparent than a real one; during life we never find the water in ascites escaping by these channels, neither in the dead body air or fluid when injected into the peritoneum. The different folds which the peritoneum forms in this course are termed processes, the principal of which, in addition to the ligaments of the several organs which shall be noticed in the description of the latter, are the lesser omentum, the great omentum, the splenic omentum, the colic omentum, the appendices epiploicæ, the transverse, and the right and left lumbar mesocolons, the mesentery, meso-cæcum, and meso-rectum.

The *lesser*, or *gastro-hepatic omentum*, consists of two laminæ, which extend from the transverse fissure of the liver to the lesser curvature of the stomach and to the upper part of the duodenum; it contains between its layers the vessels of the liver, viz., the hepatic artery to the left side, the ductus choledochus to the right, and the vena porta behind and between both; at its connection to the stomach it incloses the coronary vessels of this organ; the lesser omentum lies anterior to the foramen of Winslow; it seldom contains much adipose substance.

The *great*, or *gastro-colic omentum*, consists of four laminæ, that is, of two descending, and two ascending; the former descend from the lower end of the spleen, and from the anterior and posterior surfaces of the stomach; between these laminæ are several long and tortuous vessels, descending from the vessels of the stomach, between its two anterior laminæ, to its lower border; they then turn up and ascend between its two posterior layers as far as the colon, on which intestine they anastomose with the colic arteries; between these laminæ also is some adipose substance, the quantity of which varies very much in different subjects; it is chiefly deposited along the bloodvessels; and often amounts to a considerable quantity in the adult; in the child the omentum is usually very thin and free from fat; in the adult also it is often cribriform, or very thin and transparent; in extent also, as well as in structure, it is very variable: the omenta are the only portions of this serous membrane visibly supplied with bloodvessels; the finest injections demonstrate a network of capillaries external to the membrane, but these never permeate it, so as to appear on the serous surface; it is difficult, therefore, to account for these omental arteries; they may maintain some useful anastomosis between the gastric and colic arteries; they exist in the omentum of the young, where there is as yet little or no adipose deposit; in fact, although the omentum is anatomically traced as a continuation of the peritoneum, it yet appears a totally different structure when minutely examined by the microscope, as well as when regarded physiologically or pathologically; various opinions are entertained as to its uses or functions, but it appears to me to be wiser to admit that these are still unknown. The great omentum descends in front of the large and small intestines to the lower part of the abdomen, in general lower on the left than on the right side; (this explains the reason why the omentum is more frequently found in a hernial sac on the left than on the right side;) it then turns upwards and backwards until it reaches the transverse arch of the colon; that portion of omentum, therefore, which is

inferior to the colon, consists of four laminæ, two descending and two ascending; these, though shorter in the very young subject than in the adult, can often be separated from each other, and a distinct cavity can be seen between them; this is part of the cavity or bag of the omentum which communicates with the general cavity of the peritoneum by the opening of Winslow, and which will be more particularly described presently; at the arch of the colon the two ascending laminæ of the great omentum separate to inclose this intestine, and, again uniting, form the commencement of the following process.

The *transverse meso-colon* extends from the concave border of the arch of the colon backwards to the spine; this process is very strong and dense; it incloses the vessels of the colon, and forms a sort of division or partition in the abdomen, between the epigastric and umbilical regions, the former containing the true digestive organs, the latter, those of nutrition; no communication can take place between these except that through the duodenum, and altogether behind the peritoneum; when the transverse meso-colon has arrived at the spine, its two laminæ separate, one descends the other ascends; the descending layer is very strong, expands laterally into the right and left lumbar regions, in each of which it is reflected either partially or perfectly around the ascending and descending colon, and thus forms a short fold or process very irregular in different subjects, termed the *right* and *left lumbar meso-colons;* this inferior, or descending layer of the transverse meso-colon is also continued obliquely downwards in the middle line to form the mesentery, a process which we shall trace when we have pursued the superior, or ascending layer of the meso-colon to its termination. This lamina is thin and delicate; it ascends in front of the inferior and middle portions of the duodenum, and of the pancreas; it also covers the aorta and vena cava, and continues along this latter vessel to the liver, on the Spigelian lobe of which it expands, and on it and on the right lobe, behind the foramen of Winslow, it becomes continuous with the peritoneum, which has been reflected on the back part of the liver from the diaphragm. As this ascending layer proceeds in front of the pancreas, it is continuous on each side with the posterior layer of the lesser omentum which covers the back part of the stomach. This ascending layer may be best seen and traced by dividing the great omentum a little below the stomach, and raising this organ towards the thorax; we shall thus lay open the cavity of the omentum, and shall be able to trace the parietes of this bag through their whole extent.

The *cavity or sac of the omentum* extends from the transverse fissure of the liver superiorly, to the lower border of the great omentum inferiorly; it is bounded anteriorly by the lesser omentum, the stomach, and the anterior or descending portion of the great omentum; inferiorly it is formed by the great omentum turning on itself; and posteriorly it is bounded by the ascending portion of the great omentum, by the colon, by the transverse meso-colon, and by the superior, or ascending, layer of this process, which terminates at the liver. The cavity of the omentum communicates with the general peritonæal cavity through the foramen of Winslow; this opening is situated in the lower part of the right hypochondriac region, just above the right lumbar; it is somewhat oval, bounded anteriorly by the lesser omentum which incloses the vena porta, and the hepatic duct and artery, posteriorly by the termination of the ascending layer of the meso-colon which invests the vena cava, superiorly by the lobulus caudatus of the liver, and inferiorly by the superior portion of the duodenum. If the membrane composing the omenta be perfect, and if air be forced through this opening, it will descend behind the stomach, and will inflate the omental cavity; the great omentum, however, in general, is so cribriform that this experiment cannot be performed; the principal use of this cavity is most probably to afford a serous surface, or

cavity for the stomach to move in, or to distend into posteriorly during the progress of digestion.

The *splenic omentum* extends from the fissure in the spleen to the great end of the stomach, and is continuous with the anterior layer of the great omentum; the splenic vessels and the vasa brevia are contained between the laminæ of this process.

The *colic omentum* is a fold of peritoneum which descends from the upper part of the right or ascending colon; it generally lies posterior to the great omentum; it is composed of two laminæ, between which are contained blood-vessels and adipose substance.

The *right and left lumbar meso-colons* are folds connecting the ascending and descending colons in the lumbar regions; these are usually very imperfect, or open posteriorly, so that the back part of this intestine in each lumbar region is uncovered by peritoneum, and is connected by cellular tissue to the kidney; the right colon is usually more uncovered by it on this aspect than the left, and is there also in contact with the duodenum; both are also connected to the quadratus lumborum muscles.

The *appendices epiploicæ* are attached all along the large intestine, but principally to the transverse arch of the colon; they are small prolongations of the peritoneum, filled with a soft fatty substance; they are never found attached to the small intestine; they vary very much in different subjects in number and size; their use is not ascertained.

The *mesentery* is the largest and most remarkable process of the peritoneum: it is continuous with the descending layer of the meso-colon, and extends from the left side of the second lumbar vertebra obliquely downwards to the right iliac fossa; this is the root of the mesentery; from this it expands very much, and is folded round the jejunum and ileum intestines, and then returns again to the spine or to the inferior surface of the root; the laminæ of the mesentery can be easily separated; between them we find the mesenteric arteries, veins, and nerves, also numerous absorbent vessels and glands; the mesentery serves to support the convolutions of the small intestines and the numerous vessels passing to and from these.

The *meso-cæcum* is a fold of peritoneum which attaches the cæcum to the right iliac fossa; this process, however, is frequently imperfect; the posterior portion of this intestine being often deprived of a serous coat, and connected to the iliac muscle by cellular membrane.

The *meso-rectum* is a short fold of peritoneum which connects the superior portion of the rectum to the upper and anterior part of the sacrum; it incloses the hæmorrhoidal vessels and nerves.

The peritoneum covers the abdominal viscera in a very unequal manner, that is, some only partially or imperfectly, others almost entirely; no viscus can be wholly enveloped by it, as in every case some part must be free for the entrance and exit of its vessels, as these never perforate the membrane. The spleen, and the jejunum and ileum intestines, are among the most perfectly inclosed organs, as the peritoneum is unadherent only along the concave aspect of each, where the vessels and nerves are placed; next in degree are the stomach and the transverse colon; on each of these the membrane is unconnected along the convex as well as the concave aspect; on the liver also it is unattached at the great transverse fissure where the bloodvessels and nerves enter, and partially also along the convex or diaphragmatic border, where the veins escape from this organ; the gall bladder also is only partially covered by it, as it attaches this viscus to the liver, but does not pass between them; the right and left colons very generally want this coat posteriorly; the middle and inferior divisions of the duodenum are but loosely covered by it in front, and no part of the very termination of this intestine is attached to it, as the fasciculus of the superior mesenteric vessels is interposed; the lower

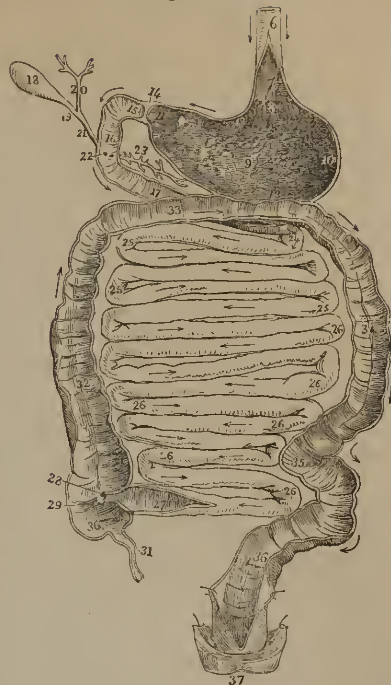
portion of the rectum is in the same predicament; the urinary bladder, the pancreas, and kidneys, are all but imperfectly covered by it; these facts are of some practical importance, and will be more particularly set forth in the description of the individual organs. The peritoneum effects several useful purposes; first, it enters more or less into the structure of the several viscera, and in some it serves as an important physical element; second, it assists in retaining the organs in a certain position, and in maintaining their different relations; third, it conducts the numerous vessels and nerves; fourth, it strengthens the walls of the abdomen, by adhering to and connecting together the muscular fasciculi of which they are chiefly composed; and lastly, by the exhalation of a lubricating fluid, it allows opposed surfaces to glide on each other without any sensible friction; it thereby facilitates the actions of the parietal muscles on the contained viscera, as well as the movements of the latter among one another.

The peritoneum is composed of the same elements as other serous membranes, namely, an external lamina which is similar to cellular or areolar tissue, containing the nutrient or functional vessels and nerves, and connected to the surrounding structure; and an internal layer, which is smooth, dense, and pearly, which appearance is supposed to depend on the existence of a fine epithelium composed of innumerable laminæ of flattened vesicles with central nuclei.

The viscera contained in the abdomen are the digestive and urinary organs; the former we shall examine first. The digestive apparatus presents a series of connected or continuous organs, each of which is concerned in some especial manner in effecting certain changes on the food, whereby it becomes fit for the nutrition of the system. The term "digestion" is commonly confined to the operation of the stomach; but it should be more extensively applied, so as to include the successive changes which the food undergoes from its reception into the mouth until it is separated in the small intestines into the nutritive portion or chyle, which is there absorbed by the lacteals, and into the residuum, which is discharged by the large intestine. Indeed, in a physiological sense, the term might be still further extended, as the chyle, most probably, is not fully elaborated for nutrition until it has been duly mingled with the blood by the circulation of the latter, and along with it purified by the respiratory process. This function, then, properly includes the processes of mastication, insalivation, and deglutition, which last conveys the food into the stomach, where the next and decidedly the most interesting change takes place, that is, chymification. In the duodenum chylification occurs; in the jejunum and ileum the chyme is separated and absorbed; and lastly, the large intestine retains the residuum for convenience, and finally expels it from the body. The whole apparatus is one long canal, extending from the mouth to the anus, lined by mucous membrane or integument, which is continuous at either end with the general integument of the body. This tube presents various shades as to organization and physical characters in different situations; it is throughout generally well supplied with vessels and nerves, although, except in some situations, it presents but few traces of sensibility, at least in the ordinary sense of that term; it is covered throughout by laminæ of muscular fibres, which are eminently involuntary, excepting towards either extremity, where voluntary power, for obvious reasons, has been endowed: varied secretions are poured forth upon its surface, some from the folds and follicles which form part of its structure, others more elaborate are derived from organs at a distance, furnished with excretory ducts for the purpose of supply; indeed the greater portion of this tissue may be regarded as an expanded glandular membrane. The length of this canal is very considerable; it is uncertain, but probably about seven times that of the height of the body; it traverses the lower part of the face, the neck, and chest, is greatly complicated and

extended in the abdomen, which it nearly occupies, also a great portion of the pelvis, and finally terminates in the anus, in front of the cocyx; in the neck it is in connection with the respiratory, and in the pelv , but not so intimately, with the genito-urinary apparatus. We have already examined the organs concerned in mastication, insalivation, and deglutition; we shall now proceed to that important and more voluminous portion of this apparatus which occupies the abdominal and a portion of the pelvic cavity; it is composed of several viscera, which may be divided into the membranous or hollow, and the glandular or solid. The membranous viscera are the stomach and intestinal tube: the latter is divided into the small and large intestine: the small intestine is subdivided into the duodenum, jejunum, and ileum; the large intestine into the cæcum, colon, and rectum. The glandular viscera are the liver, spleen, and pancreas. We shall consider the membranous viscera first, and commence with the description of the *stomach*, which is the most important part of the apparatus, the principal change of the food being accomplished in this organ.

Fig. 45.*



The *stomach* is the most dilated portion of the alimentary canal; its capacity is very variable, depending in part upon the degree of distension or contraction before death; it is placed between the œsophagus and the duodenum, and communicates with both; it is situated in the left hypochondriac and epigastric regions, and a small portion of it extends into the right hypochondrium: from the left side it passes across the epigastric region, obliquely downwards and forwards, and near its right or pyloric extremity it bends a little upwards and backwards. It is connected to the diaphragm by the œsophagus and by the peritoneum; to the spleen by the splenic omentum and vasa brevia; to the liver by the lesser omentum; and to the arch of the colon by the great omentum; it is, therefore, nearly a fixed viscus, and not liable to displacement, although it has been found drawn downwards in old and very large

* The alimentary canal laid open from the lower extremity of the œsophagus to the rectum. 6. The œsophagus. 7. The internal surface of the œsophagus. 8. The cardiac or œsophageal orifice of the stomach. 9. The internal surface of the stomach. 10. The left or splenic extremity. 11. The right or pyloric extremity. 12. The greater curvature of the stomach. 13. The lesser curvature. 14. The pylorus. 15. The superior transverse portion of the duodenum. 16. The middle or perpendicular portion. 17. The inferior transverse portion. 18 The gall-bladder. 19. The cystic duct 20. The hepatic duct. 21. The ductus communis choledochus. 22. Its aperture in the duodenum. 23. The duct of the pancreas dissected from the gland; its aperture in the duodenum is seen close to that of the ductus choledochus. 24. The commencement of the jejunum. 25. 25. The jejunum. 26. 26. The ileum. 27 The ileum opening into the great intestine. 28. The ileo-colic valve. 29. The ileo-cæcal valve. 30. The cavity of the cæcum. 31. The appendix vermiformis. 32. The ascending or right lumbar colon. 33. The transverse arch of the colon. 34. The left or descending colon. 35. The sigmoid flexure of the colon. 36. The rectum. 37. The anus.

umbilical herniæ, also in cases of enlarged spleen. If the stomach be moderately distended with air or fluid its form and connections can be better understood; it will then appear somewhat of a conical figure, the base to the left side, the apex to the right, the intermediate part being somewhat curved; it will then also present two extremities, the left and right; two orifices, the cardiac and pyloric; two surfaces, an anterior or superior, a posterior or inferior; and two curvatures or edges, the lesser or concave, the greater or convex. The *left* or *splenic extremity* is very large (*great cul de sac*), swells into the left hypochondrium beneath the ribs, so as nearly to conceal the spleen. The *right* or *pyloric extremity* is much smaller, is cylindrical and slightly convoluted like an intestine: it lies anterior and inferior to the left or splenic end, and extends to the fundus of the gall bladder or to the edge of the lobulus quadratus of the liver; it sometimes descends into the umbilical region; it forms the apex of the general cone, and is distinguished from the duodenum by the circular contraction of the pylorus, a little to the left of which the stomach is often found somewhat dilated towards the convex border, into a sort of sinus or *cul de sac* (*antrum pylori*): sometimes also there is a smaller dilatation, nearly opposite to this, on the lesser curvature. The *cardiac* or *œsophagial orifice* is the highest point of the stomach; it is situated between the left or great end and the lesser curvature, about three inches from the former; it is surrounded by vessels and nerves, and is connected to the diphragm by the peritoneum. The *pyloric orifice* is between the stomach and the duodenum; it lies to the right side of the spine; it is movable to a certain extent, its position is therefore variable; in general it is in contact with the liver and gall bladder, and is anterior to the pancreas and to the right epiploic artery; it is inferior, anterior, and to the right side of the cardiac orifice, has a peculiar firm, hard feel, and a constricted appearance. The angles at the cardiac and pyloric orifices are differently affected according as the organ is contracted or distended; in the former state there is no angle between the œsophagus and the stomach, whereas in the latter it may become even an acute one; the contrary is the case at the pyloric; during the empty state of the stomach this forms with the duodenum an acute angle, convex above; while in the distended condition the pylorus leads backwards and downwards into the duodenum; these alterations in the form and aspect of these orifices, are in conformity with their respective functions. The *anterior surface* is below the xiphoid cartilage; it looks upwards and forwards, and is in contact with the diaphragm, the ribs, and the left lobe of the liver, and, when distended, with the abdominal parietes. The *posterior surface* looks backwards and downwards; it forms the front of the bag of the omentum, the cavity of which separates it from the meso-colon, pancreas, and duodenum. The lesser, or *concave edge,* looks backwards and upwards towards the spine and lobulus Spigelii of the liver; this edge, near the pylorus, is convex, the great edge being concave opposite to this; the lesser omentum is attached to it, and the coronary vessels run along it. The *great* or *convex edge* looks forwards and downwards towards the colon; to it the great omentum and the epiploic vessels are attached, and occasionally some lymphatic glands: in the empty or contracted state these edges are thin, and directed almost vertically, but when distended, they become enlarged and round, and continuous with the surfaces; the convex edge is then directed forwards as well as downwards towards the abdominal muscles, and the concave edge backwards and upwards towards the aorta and the spine.

The stomach is composed of *three proper tunics*—a serous, a muscular, and a mucous: these are connected to each other by laminæ of cellular membrane, which are regarded by some as the *common* tunics. The *serous* or *peritonœal coat* is derived, as was before explained, from the laminæ of the lesser omentum, separating at the lesser curvature, expanding over the sur-

faces, and uniting along the convex edge to form the great omentum; it is loosely united to the edges, but almost inseparably to the middle of each surface and to the pyloric extremity; along each edge or curvature a triangular space is left, to which this membrane does not adhere; that along the convex border is much the wider; these spaces are enlarged during the distension of the organ, and facilitate its expansion; whereas, if the peritoneum adhered in these situations as closely as to the surfaces, its want of extensibility would interfere with the sudden enlargement of the stomach. These spaces also afford a suitable inclosure for the bloodvessels; the coronary being contained in that along the lesser, and the epiploic in that along the greater curvature. A layer of very fine subserous or cellular tissue connects this to the following tunic, the *muscular;* this consists of fibres which run in three different directions; the first or superficial are longitudinal; they are continued from the longitudidal fibres of the œsophagus, are radiated and scattered over its surfaces, and are very strong along the curvatures, particularly on the lesser, the form of which they retain; some fibrous bands usually run superficial to these in the subserous tissue; these fibres are very strong near the pylorus; some end in its constriction, and others are continued on the duodenum. The middle layer of fibres run circularly; they commence at the left extremity, or *cul de sac*, and are arranged in nearly parallel rings; they are weak and few on the left end, but very strong to the right of the centre, where they often cause a constricted appearance around the stomach, as if dividing it into two portions. The circular fibres again increase in thickness as they approach the pylorus, the sphincter of which they form: these fibres do not form perfect circles, the extremities of each fasciculus turn obliquely to one side. The third set of fibres take a very irregular or oblique direction; they are most distinct on the great end, or *cul de sac,* and appear as a continuation of the circular fibres of the œsophagus, and run in loops or arches nearly parallel to the long axis of the stomach. The muscular coat of the stomach is very variable as to color and development; it is usually pale, sometimes almost white and semi-transparent; along the curvatures, particularly the lesser, it is often not only strong, but very red, and sometimes contains a fibrous or tendinous band; it is always thin over the splenic end, or *cul de sac,* and much thicker at and near the pylorus; in general its strength is in an inverse ratio to the size or capacity of the organ. These several planes of fibres do not form so many distinct layers, but rather interlace, so as to form more or less of an areolar muscular tissue; the areolæ are large in the distended condition of the organ. Beneath the muscular tunic is the second lamina of cellular tissue, which contains the minute divisions of the nerves and vessels of the stomach, and has been, by some, called the nervous coat of the stomach. This coat is connected to the muscular by numerous processes or septa, and to the mucous by cellular tissue, vessels, and nerves; it is composed of a dense network of filaments and laminæ, which possesses considerable strength, so as to resist distension in the muscular areolæ. This tunic may be examined either by removing the serous and muscular, or, when the stomach has been everted, by raising a portion of the mucous membrane; in the fine cellular tissue, which connects this to the mucous or lining coat, is contained the network of capillary vessels for the supply of the latter; it gives support to the mucous membrane, and forms, as it were, the framework of the organ; and, therefore, some anatomists consider this tunic as the deep layer of the mucous membrane, and do not enumerate it among the distinct coats of the stomach. The internal or *mucous* coat, also called villous, from its soft, velvet-like appearance, is continuous with that lining the œsophagus and duodenum. In order to examine it the stomach should be removed from the subject, everted, or opened longitudinally, and washed under a gentle stream of water, as it is usually covered with viscid,

adhesive, mucous and alimentary matters. It presents, if recent and normal, a pale pink or rosy tint; but the shade of color is very variable, and depends on many circumstances; in cases of sudden death, and the organ empty, it has been found of a pale red, but, if digestion has been in progress, of a more vivid tint; if some days have elapsed between death and examination, it often presents brown or black patches, chiefly in the splenic end and around the large bloodvessels; such patches are often soft, pulpy, and decomposed, and may be the effects of transudation of blood, or of putrefaction, or of solution by the gastric fluid. The shade of color may also depend on the previous state of the organ, as to health or disease; on its state at the time of death, whether full or empty; and if in the former, on the nature of its contents, and the influence of the gastric fluid upon the latter; also on the presence of bile, &c. This membrane is always thrown into folds or rugæ, of which there are different species; the most prominent and numerous are nearly parallel to the long axis of the organ; some bend off tortuously from this direction; these rugæ are most distinct in the pyloric portion; they are obviously designed to admit of the rapid and easy distension of the stomach, particularly in the circular direction; the mucous tissue alone enters them; they have no analogy to the permanent mucous folds, or valvulæ conniventes, in the intestinal tube; these folds are intersected here and there by others, so as to give rise to an areolated appearance; these will facilitate longitudinal enlargement. If a recent and contracted stomach be filled with and immersed in spirits for some days, and then a portion of its anterior wall removed, the form of the organ and these several rugæ are well preserved. At the cardiac orifice the lining membrane is plicated longitudinally, and somewhat festooned, the borders being marked by a slight projection, which in some cases is very abrupt and very distinctly marked; but not so in others, indeed it seldom equals the representations in the engravings of this part; these plicæ chiefly consist of the epithelium continued from the œsophagus, where it is white, firm, and scaly, like epidermis; whereas in the stomach beyond this it becomes soft, thin, and of a pink or reddish tint. Corresponding to the pylorus is a remarkable circular fold, with a small aperture in the centre (*pyloric valve*); this fold is encircled by a strong band of sphincter fibres, upon which its valvular powers depend, as it has none such in the dead body; during life, when the sphincter acts, it can close the opening between the stomach and the intestine, and prevent the passage of any matter equally from one into the other. The mucous membrane, on its gastric surface, differs in organization from that on the duodenal aspect, being thicker and more follicular. If a stomach and duodenum be filled with air and dried, and in the course of a few days the pylorus with about two inches of the canal on either side removed, a very useful preparation of this valve is made; its circular, partition-like form and central aperture are well seen, and bear some analogy to the iris and the pupil. This coat of the stomach is soft and thin, easily broken and detached, especially from the splenic end, where it is often found pulpy, and breaks off in shreds; in the pyloric portion it is thicker and stronger, and can be dissected entire from the other coats: however, these, as well as other physical characters, much depend on the general condition of the organ and the length of time elapsed since death. Occasionally, in a very recent stomach, we may observe a marked line of distinction in the organization of the mucous membrane in the splenic and pyloric portions; this line will correspond to the circular constriction caused by the muscular fibres, thus showing some approximation to the bilocular or compound multiple stomach of many inferior animals. This membrane sometimes presents a peculiar granular appearance; I have observed this more frequently along the lesser curvature, also near the pylorus; it probably depends on an hypertrophied state of the mucous glands and follicles. When the surface

of this membrane is cleared of all adherent mucus, different portions of it may be removed and examined, some with a magnifying lens through a thin stratum of water, others floating in fluid beneath a glass globe, and others extended on thin plates of glass; the surface will be found to be very irregular, though so soft and smooth to the feel. Numerous follicular papillæ, but not true villi, project, and leave between them small depressions or pits studded with minute holes; these pits are more or less circular, and are bounded and separated by the follicular elevations; they are most distinct towards the pyloric portion of the stomach; four or five foramina are seen in each; these are the orifices of the small glands and ducts that elaborate the gastric fluid, the mucus probably being furnished by the follicles. If the cut margin of the membrane be examined, it will be found chiefly composed of tubes closely applied to each other, their cæcal ends lodged in the submucous tissue, and their open extremities are these small holes in the pits or alveoli on the surface of the membrane; some are short and straight, others are longer, convoluted, and partially dilated; bloodvessels pass between these, and cover them with a vascular network.

Much of our information as to the characters of this membrane during life, as well as of the process of digestion, has been accidentally derived from that interesting case of Martin, noticed and recorded by Beaumont, and published by Coombe. In this case a wound had divided the abdominal parietes and opened the stomach; a fistulous passage formed leading into its cavity, and the general health having recovered, an opportunity was thus obtained for the inspection of this membrane, and for the examination of many of the phenomena of digestion. The following facts are recorded:—"The inner coat, in its natural state, is of a light or pale pink color, varying in hue according to its full or empty state, of a soft, velvet-like appearance, and constantly covered with a thin, transparent, viscid mucus. When aliment or any irritant is applied to the surface, innumerable lucid points and fine nervous or vascular papillæ can be seen arising through the mucous coat, from which distils a pure, limpid, colorless, slightly viscid fluid. This is invariably acid. The mucous of the stomach is less fluid, more viscid, semiopaque, a little saltish, and has no acidity. The gastric fluid is never accumulated while fasting, and is seldom, if ever, discharged, except under the excitement of food or other irritation; it is secreted only in proportion to the quantity of food supplied, provided there is not more of the latter than the system requires; and, if an excess of food be taken, the residue either remains in the stomach, or passes into the bowels in a crude state, and gives rise to nervous irritation, pain, and disease. In disease or partial derangement of the healthy function of this membrane, it presents various appearances: in febrile conditions, from any cause, it sometimes becomes red and dry, at other times pale and moist, and the secretions vitiated; scarcely any mucus, and the follicles flat and flaccid; sometimes it presents an appearance of eruptions, pimples here and there, sharp and red, and often filled with white purulent fluid, red patches, aphthous crusts, and abrasions of the surface; these are usually accompanied by dryness of the mouth and tongue, thirst and fever, and, when the healthy state of the stomach is restored, the tongue becomes clean and natural." We shall revert to the minute structure of this membrane when we have examined the remainder of the alimentary canal, and shall then also contrast it in different situations.

The stomach is very freely supplied with blood from the cæliac axis; the coronary and epiploic arteries, with the vasa brevia, inclose it in a sort of network of inosculations. During its distension the trunks of the two former arteries are extended close to the organ, along its curvatures, but, when empty, they are removed to some distance from it, and are then flaccid and coiled. The veins are numerous and large, and join the portal system. The

eighth nerve of the left side expands on the anterior, and that of the right side on the posterior surface: both form a plexus around the cardiac orifice, and appear to be chiefly distributed to the muscular tunic. From the solar plexus of the sympathetic numerous nerves are also derived; these accompany the arteries, are supported by them, and penetrate the submucous tissue as far as the eye can trace them. The stomach is not provided with lacteals, at least but very sparingly; absorption of fluids, however, rapidly takes place in it, and is effected through the medium of the venous capillaries by endosmose. The mucous coat of the stomach secretes the fluid called the gastric juice or acid, which is generally believed to have the remarkable properties of being powerfully solvent and anti-putrescent. In the stomach the food undergoes the first important change in digestion, being here converted in a soft, homogeneous, pulpy mass, called chyme. To effect this important change, and which appears to be essentially chemical, the food must remain inclosed in the stomach for some time, varying as to the nature and quantity of the mass, as well as the condition of the organ and of the general health; a gentle contraction, as well as the elasticity of the structures at the cardiac and pyloric orifices, are sufficient to retain it. As each superficial stratum is digested, it is moved on by the gentle peristaltic action of the muscular coat, and transmitted through the pylorus, the sensible and irritable endowments of which are such as to oppose, at least for a considerable period, the transit of any large or undigested substance. Beaumont has observed, "that the food entering the stomach from the œsophagus, in successive waves, is subjected to a peculiar peristaltic action, which effects an intermixture of the gastric fluid with the alimentary mass, and aids the solution of the latter by gentle trituration. The stomach is also constantly agitated by the respiratory movements. The food, after passing the œsophageal orifice, moves from right to left along the small arch, then from left to right along the large curvature, and then returns and performs similar revolutions; a revolution occupies from one to three minutes; they are slower at first than after chymification has advanced, when there is also an increased impulse towards the pylorus. It is probable that portions of chyme are constantly passing into the duodenum, as the alimentary mass progressively diminishes in bulk. This accelerated impulse appears to be effected by that portion of the circular fibres which embraces the organ about four inches from the pylorus, and which in the latter part of the process, is found so constricted as almost to separate the two portions in an hour-glass form, so that, in introducing a long thermometer, the bulb was at first resisted, then allowed to pass, and then grasped and drawn in. Hence it is evident that this contraction tends to resist the passage of any solid matter into the pyloric portion of the stomach, while the fluid parts readily escape: these peculiar motions continue until the stomach becomes perfectly empty."

The *duodenum* is the next portion of the alimentary canal; it is so named from its length (which is from eight to nine inches), being equal to about twelve fingers' breadth: this is the first and shortest, but most dilatable division of the small intestine; it extends from the pylorus to the root of the mesentery, where the jejunum commences; it lies partly in the right hypochondriac and partly in the right lumbar and umbilical regions; the greater portion of it is deep-seated, and surrounded by cellular and adipose tissue; it takes a semicircular course around the head of the pancreas, convex to the right side. This course may be divided into three parts: the first, or superior transverse; the second, or perpendicular; and the third, or inferior transverse. The *superior transverse portion* ascends from the pylorus obliquely backwards and to the right side, beneath the edge of the liver, so as to touch the gall-bladder. Here the intestine makes a sudden or acute turn (the superior angle), and the *middle* or *perpendicular portion* of it commences; this

descends in front of the right kidney, as low as the third lumbar vertebra, where it makes a second turn (the inferior angle), from which the *inferior transverse portion* extends obliquely upwards across the spine; and at the left side of the first or second lumbar vertebra ends in the jejunum. The duodenum differs so materially in function and structure from the remainder of the small intestine as to have been regarded by some as a second stomach; it is fixed in its situation, being only partially covered by the peritoneum, and is of much larger calibre, particularly near the inferior angle; it can never be protruded in hernia: its muscular coat is very strong, and the valvulæ conniventes very numerous and large. The superior transverse portion, about two inches in length, is more contracted than any other part of it, and is covered on both surfaces by the peritoneum, like the stomach, and is, therefore, more movable than the rest of the intestine. The perpendicular portion is concealed by the omentum and by the colon, and is covered by the ascending layer of the meso-colon; this portion lies on the right kidney, vena cava, and ductus choledochus, and has no peritoneum posterior to it; it is, therefore, fixed, and is dilatable; it is above three inches long. The biliary and pancreatic ducts perforate the inner side of this division of the duodenum; these pass through its coats very obliquely, and open into the intestine, sometimes distinctly and at other times conjointly, on a small papilla, opposite the inferior angle; and hence the necessity for this intestine being fixed. The inferior transverse part of the duodenum passes across the spine, the right crus of the diaphragm, the aorta, and the right renal vessels; like the middle portion, it is only partially covered by the peritoneum, being placed between the layers of the meso-colon; the sac of the omentum separates it from the back of the stomach. Its lower border may be seen, without dissection, projecting through the inferior layer of the meso-colon; its upper border adheres to the pancreas, except where the superior mesenteric vessels intervene; these pass in front of the termination of this part of the duodenum, and appear to compress it against the aorta, so as to retard the passage of its contents into the jejunum; a marked line or angle of distinction is thus made externally between the duodenum and jejunum, but internally no definite line is to be observed. The arteries of the duodenum are derived from the hepatic, splenic, and superior mesenteric; the veins join the porta, and the nerves are from the solar plexus. In the duodenum the process of digestion is completed; the chyme is mixed with the biliary and pancreatic fluids, and a separation takes place between the chyle and the excrementitious part of the food. We shall consider the structure of this intestine presently.

The *jejunum* and *ileum intestines* are partially concealed by the omentum. If we raise the process and the arch of the colon, and place them on the edge of the thorax, the convolutions of these intestines will be seen in the umbilical, hypogastric, and iliac regions, convex anteriorly, concave posteriorly, and attached to the mesentery; the jejunum commences in the left lumbar, and the ileum ends in the right iliac region. There is no exact division between these two intestines; the upper two-fifths are named the jejunum, and are placed higher in the abdomen than the ileum, which is the name given to the three remaining fifths; the former is redder, feels thicker, and is larger than the latter, which is pale and thin. These differences are striking when we compare the commencement of the jejunum with the terminating portion of the ileum; in the intermediate space, however, they are gradually lost; they depend on the greater vascularity and number of valvulæ conniventes in the first than in the second, but there is certainly no accurate anatomical reason for this division. From the duodenum the jejunum first passes forwards and to the left side; it then descends into the middle of the abdomen, is folded upon itself over and over again, and extends into different regions, and finally, the terminating portion of the ileum rises out of the pelvis from

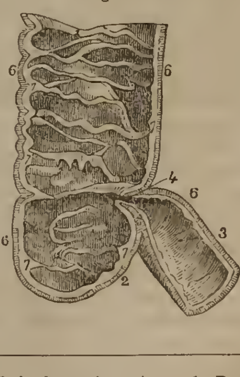
left to right, and joins the cæcum at an acute angle convex upwards. The general direction of the canal is from the left side downwards and to the right, and its dimensions decrease in this course, though the ileum is often dilated near its entrance into the cæcum. The distance between the commencement of the jejunum and the end of the ileum is not more than five or six inches; yet, if the coils of the tube be unfolded, it may be extended to fifteen, or even twenty feet. The length of the canal, however, cannot be accurately determined; if detached from the body, flaccid and extended, it will measure longer than if distended and *in situ;* it does not bear any uniform ratio to the height of the individual, but usually it is three or four times as long. The mesentery being broader in the centre than at its extremities, supports the numerous convolutions in a wonderful manner, free from any entanglement, compression, or obstruction, and though to a certain degree retained in their position, yet they enjoy considerable mobility; this, together with the yielding tissue of which they are composed, allow them to mould themselves to the adjacent parts, and to accommodate themselves to every alteration induced by change of position or by muscular action. At the same time, however, this mobility, which is greater in some convolutions than in others, admits of the frequent occurrence of hernia, as also of intus-susceptio or invagination. Each convolution is curved into more than a semicircle, convex forwards, concave towards the mesentery, but the size and figure of each is constantly varying. These intestines are in contact with the abdominal parietes, except where the omentum intervenes, and they are separated from the spleen, stomach, and liver, by the transverse colon and meso-colon; the large intestine encircles them; the arch of the colon is anterior, but the right and left colons and the rectum are behind them. Several coils occupy the peritoneal *cul de sac* in the pelvis, between the bladder and rectum in the male, and before and behind the uterus in the female. To the ileum, near the lower end, a small digital appendix or diverticulum is occasionally found attached, the embryonic remnant of the vitelline sac. The form of the small intestine is nearly circular, but a little concave posteriorly where the mesentery is attached, and where there is a small triangular space in which the peritoneum does not adhere; this loose cellular space facilitates the distension of the intestine and incloses its vessels and nerves. We shall consider the structure presently.

The *large intestine,* from four to five feet long, forms about one-fifth of the canal; is divided into cæcum, colon, and rectum; it differs from the small not merely in size, but in being cellular or sacculated when distended; small processes also (appendices epiploicæ) are attached to it; three strong, longitudinal, muscular bands may also be observed, chiefly in the cæcum and colon, and appear to pucker it, and so cause the cellular appearance; these bands also possess much elasticity, and in some animals are decidedly elastic. The large intestine is pale and thin, and has but few valvæ conniventes; it extends from the right iliac region to the anus, encircling the convolutions of the small intestine; in some situations it is superficial, in others deep-seated; a portion of it is found in every region of the abdomen; from the right iliac it ascends through the lumbar into the right hypochondriac, then traverses the epigastric and the umbilical tortuously; it next sinks into the left hypochondriac, descends through the lumbar into the left iliac, and finally sinks through the hypogastric into the pelvis; its lumbar portions are fixed, but its transverse arch and left iliac coils are very movable. Its size is variable, though in general larger than the small intestine, yet it is often found in the child contracted into a cord-like form, while in the adult and aged it is sometimes dilated and distended with air to a surprising extent. The cæcum is the largest part; from this it gradually decreases until within about two

inches of the anus, where it is usually expanded previous to the contracted anal opening.

The *cæcum*, or *caput coli*, is a *cul de sac* in the right iliac fossa, which it nearly fills, fixed by the peritoneum, which in general covers it only inferiorly, anteriorly, and laterally, while cellular membrane connects it posteriorly to the iliac and psoas muscles and iliac fascia: in some, however, the peritoneum covers it all round, and connects it so loosely by a meso-cæcum that it may escape in hernia; it is covered by the abdominal muscles, and sometimes partially by the coils of the ileum; it lies beneath the kidney, and is continuous with the ileum and the colon; is somewhat triangular, the apex below, and directed inwards to the left side; the base above, and somewhat to the right, joins the colon at an obtuse angle, convex outwards; there is no exact limit between them; on its external surface are three irregular protuberances, one anteriorly and two posteriorly. The *appendix vermiformis* proceeds from the left side of its lower and posterior part; this is a small, tortuous, tubular *cul de sac*, about the size of a goose-quill; it falls over the brim of the pelvis, and communicates with the cæcum, just below the ileum, by a semi-valvular opening; a mesentery connects it in this situation; variable as to size and length,—in some only an inch long, or less, in others five or six,—its position also varies, being sometimes turned up behind the cæcum; it has also been found in inguinal and femoral hernia, and has even caused an internal strangulation, by having become twisted round a convolution of the ileum. Its use is not ascertained; it may be regarded as an arrest of development, or rudiment of the more highly developed cæcum of other animals. Before birth it proceeds from the lower end of the cæcum, and appears like its contracted, tapering end, from which the longitudinal bands proceed; but as the cæcum enlarges it bulges forwards and downwards, while the appendix assumes the appearance of an offset directed inwards and backwards towards the pelvis. The ileum joins the left or inner side of the cæcum at an acute angle; it appears to perforate it, the peritoneum and external muscular fibres of the ileum being continued into the corresponding parietes of the cæcum, while the circular fibres and mucous coat of the ileum protrude into the cæcum to form valves, as may be seen by opening the latter in a perpendicular direction on the opposite, that is, on the right side, and washing out its contents. We then perceive the opening of the ileum, narrow, like a transverse or button-hole slit, looking obliquely downwards and outwards towards the right os ilii, and protected by two semilunar folds of mucous membrane, which inclose a few muscular fibres. These valves should be examined both in the recent state, *in situ*, or removed and floated in water, or in a dry, distended preparation. The inferior, or *ileo-cæcal valve*, is the larger, is somewhat vertical, it secures the ileum against regurgitation from the cæcum; the superior, or *ileo-colic valve*, is smaller, and rather horizontal, it secures the ileum against regurgitation from the colon; these are united at their extremities (*commissures*), and from each commissure a fold is continued round on the inner side of the cæcum; these are the fræna or *retinacula* of the valves, through the medium of which, and of the

Fig. 46.*



* The termination of the ileum and the commencement of the large intestine. 1. Portion of the right or ascending colon. 2. The cæcum or caput coli. 3. Portion of the ileum. 4. The ileo-colic valve. 5. The ileo-cæcal valve. 6. 6. Muscular coat, the peritoneum having been removed. 7. 7. Submucous and mucous coats, forming folds.

commissures, the distension of the cæcum closes the ileo-cæcal foramen. Each valve is composed of two laminæ of mucous membrane, inclosing cellular tissue and a few muscular fibres; the iliac surface of each differs in organization from the cæcal. These valves are unlike that of the pylorus, or the valvulæ conniventes; in the dead body their valvular powers vary; I have sometimes been unable to force even air through them from the cæcum or colon, but in other cases they have offered but little resistance; they appear perfectly adequate to oppose the reflux of any solid or consistent substance, and they are certainly more effective in a recent specimen than in one long dead. The cæcum is provided with the same longitudinal bands and appendices epiploicæ, and presents the same sacculated appearance as the colon; it has no valvulæ conniventes. The *colon* extends from the cæcum to the rectum; it is divided into four portions, the right or ascending, the middle or transverse arch, the left or descending, and the sigmoid flexure; there is, however, no mark of distinction whatever as to structure between these different divisions.

The *ascending colon* extends from the cæcum to the inferior surface of the right lobe of the liver, which it marks with a superficial depression. This portion of the colon is concave anteriorly, and covered by the peritoneum and by the abdominal muscles; it lies on the right kidney and quadratus lumborum muscle; the duodenum and psoas muscle are connected to it internally; the superior extremity is generally tinged with bile, from being in contact with the gall-bladder; it is fixed by the peritoneum, which only passes in front of it, though occasionally it extends round it and forms the right lumbar meso-colon; the convolutions of the small intestines separate it from the abdominal parietes.

The *transverse arch of the colon* turns off at a right angle from the last, and extends tortuously from the gall-bladder in the right hypochondrium across the inferior part of the epigastric and the umbilical region, as far as the spleen in the left hypochondrium; it is covered by the abdominal muscles and the great omentum, and lies anterior to the small intestines: on the right side it is connected to the liver, in the middle to the stomach and to the great omentum; and its left extremity, which is superior and posterior to the right, is attached to the spleen by the peritoneum: it is very movable, is sometimes close to the stomach in the epigastrium; at other times it lies in the umbilical, and even descends into the hypogastric region, and is, therefore, frequently protruded in hernia; the convexity of the arch is directed forwards, and the concavity backwards, but its course is often so serpentine that the term "arch" is not very applicable. It is supported by the transverse meso-colon, which is attached to its posterior concavity; the two laminæ of the great omentum descend in front of it without adhering to it, but when these have ascended they are attached to its anterior border, and then separate to inclose this intestine in their progress to become the meso-colon. The appendices epiploicæ are very numerous on this part of the colon.

The *left* or *descending colon* extends from the spleen to the iliac region, behind the small intestines, is longer than the right, and deeper seated; it is connected posteriorly to the kidney and to the quadratus lumborum and psoas muscles by cellular tissue; the peritoneum covers it only in front: from this circumstance, and from its proximity to the rectum, it has been selected as the most suitable situation for making an artificial anus, in case of obstruction in the rectum. The anatomical relations of the right colon, with respect to the peritoneum, are equally favorable, if not more so, for such an operation. In some cases, on the left side, as upon the right, the peritoneum envelopes this intestine, and forms a fold called "left meso-colon;" if the intestine be contracted, this is more distinct, but, if the former be distended, the latter becomes expanded, and the intestine bulges posteriorily between its layers, so as to be uncovered by the peritoneum, and therefore more eligible for puncture.

The *sigmoid flexure* is connected so loosely in the iliac fossa that a great portion of it often lies in the pelvis: this part of the colon is partially covered by the small intestines, and connected to the psoas and iliac muscles, to the ureter and spermatic vessels; it is surrounded by peritoneum, which forms a loose fold (the iliac meso-colon) of very variable extent; this fold is often so loose that this part of the colon is as free and floating as the small intestines; it may, therefore, be found in other regions of the abdomen and in the pelvis, and may also protrude in hernia. It first passes upwards in front of the left colon, then descending it forms two or more coils, and joins the rectum opposite the left ilio-sacral symphysis, but without any precise distinction; its size as well as length vary considerably; it usually occupies the greater portion of the iliac fossa, and, if distended, can be felt and examined during life through the abdominal parietes.

The *rectum*, or straight intestine, extends from the sigmoid flexure of the colon to the anus; it commences opposite the left ilio-sacral articulation, and descends obliquely towards the middle line as far as the lower end of the sacrum; it then bends forwards towards the perinæum, and lastly, turning a little backwards and downwards, it ends at the anus an inch or an inch and a half from the coccyx; its course, therefore, is not straight, but curved both in the lateral and antero-posterior direction. As to the former, it commences opposite the left ilio-sacral symphisis, and descends obliquely to the median line as far as the middle of the sacrum, and then continues in that line to the anus. This course, however, is variable; it not unfrequently happens that the rectum commences opposite the right side of the base of the sacrum, and descends obliquely to the left; the antero-posterior curvature is double, the first or superior is concave forwards, is long and gradual; the second, or inferior, is short and convex forwards, and is in relation to the parts in the perinæum rather than to those in the pelvis; by this latter curvature backwards it separates from the urethra in the male, and from the vagina in the female. These points, however, cannot be fully ascertained until the dissection of the pelvis and perinæum; in the examination of these regions, therefore, we shall revert to those connections of the rectum: in the fœtus these curvatures scarcely exist, and this intestine is then nearly straight, as it is in most other animals. The rectum is connected posteriorly to the sacrum and coccyx by the meso-rectum superiorly, and by vessels and nerves inferiorly, and is separated from the former by the pyriform muscles and sciatic plexus of nerves; anteriorly to the peritoneum above, and below, in the male subject, to the inferior fundus of the bladder, the vesiculæ seminales, and the prostate gland; in the female, to the left ovary and Fallopian tube, uterus, and vagina: along the sides of the rectum is a considerable quantity of cellular tissue, also several vessels, particularly tortuous veins; inferiorly the levatores ani muscles cover and support the sides of this intestine, and its lower extremity is surrounded by the orbicular and cutaneous sphincters; it is fixed not only by these several attachments, but also by the pelvic fascia, which is reflected upon its forepart and sides: it cannot, therefore, be displaced in hernia, but is liable to invagination from above, and to eversion or prolapsus of its mucous coat below, improperly called "prolapsus ani." The rectum is separated superiorly from the bladder in the male, and from the uterus in the female, by the *cul de sac* of the peritoneum, which may or may not contain some of the small intestine, according to the state of the pelvic viscera. The rectum is only partially covered by the peritoneum; in the superior third this membrane covers the intestine all around, forming the meso-rectum behind it; in the middle third it is only connected to the forepart, and somewhat to its sides; and to its inferior third it is wholly unattached. The rectum is more cylindrical and less sacculated than the colon, and the cells present a different arrangement in consequence of the peculiar disposition of the lin-

ing membrane; it is found in general much dilated about an inch above the anus.

As the food is propelled onwards through the intestines, both large and small, it becomes mingled with a vast quantity of fluid (*succus intestinalis*), secreted by the mucous glands and follicles. In the jejunum and ileum the chyle is absorbed by their numerous villi; the length and tortuosity of the tube, and its numerous valvulæ conniventes, are admirably adapted to increase the extent of this secreting and absorbing surface, and at the same time to retard the progress of the food, and to penetrate and subdivide the mass, so as to search out, as it were, and extract all the nutriment or chyle it may contain. In the large intestine the contents acquire their fæculent properties, the first traces of which they exhibit in the cæcum. In their passage along this part of the canal the absorbents may probably continue to take up any chyle that may have escaped those in the ileum, as also the watery parts of the food, and the fæces become hardened by degrees, and moulded or figured according to the length of time they are lodged in the cells of the colon; the great length of this tube, as well as its yielding structure, adapt it as a reservoir capable of retaining a considerable quantity, and thus obviating the inconvenience of frequent defæcation. The rectum also contributes to the same effect, being retained in a closed state by the sphincters and supported by the levatores ani muscles. When the evacuation of the bowels is called for by the peculiar sensations in the part, the contents are expelled partly by the muscular action of the rectum and the concurring relaxation of its sphincter, aided by the voluntary contraction of the diaphragm and abdominal muscles.

The large and small intestines possess the same structure or number of coats, viz., the serous, muscular, fibrous, and mucous, but these, being differently modified in different situations, require to be examined distinctly in each division of the tube. Remove the following portions of intestine, including each part between ligatures, having first distended them with air or fluid: a portion of duodenum, of jejunum near its commencement, of ileum near its termination, of the arch of the colon, and of the upper part of the rectum; portions of each also should be inflated, dried, and opened, while other sections may be everted and suspended in fluid.

Structure of the Duodenum.—It has been already stated that the serous tunic is only partial; the superior transverse portion, like the stomach, is perfectly invested by it, excepting along the superior and inferior borders, where its laminæ inclose small triangular spaces; the middle and inferior divisions are covered by peritoneum only in front, and are very loosely connected with it; laterally and behind cellular tissue fixes this intestine in its place; the very termination of it has no connection whatever to serous membrane, as the superior mesenteric vessels intervene and lie in front of it. The muscular coat is formed of strong red fibres, which take a circular direction; there are very few longitudinal fibres to be observed along it, except on the superior transverse portion, which portion being movable, can be shortened by their action; but on the middle and inferior divisions, which are fixed, such fibres would be useless. The fibrous and mucous coats are analogous to those of the jejunum and ileum, and may be examined at the same time.

Structure of the Jejunum and Ileum.—The serous coat forms a perfect investment, excepting in the small triangular space along their concave border, which incloses the nutrient vessels and nerves, and by the expansion of which the distension of the tube is admitted without undue extension of the investing membrane itself. The peritoneum is very fine, and connected to the next coat by extremely delicate cellular tissse, in which adeps is never deposited. Although this serous coat is transparent, and so thin as to be difficult of removal, yet it is wonderfully strong, and serves to limit or restrict the disten-

sion of the tube. The muscular coat is not so strong as on the duodenum, but more evidently consists of two sets of fibres; the longitudinal are the most superficial; they are very pale and indistinct, except along the anterior or convex side of the intestine; they are usually torn off with the peritoneum in the dissection, they are so thin and transparent; they are short; the ends of one fasciculus being received between those of two others. The circular fibres lie beneath these; they are more distinct, but also very pale: no fibre passes perfectly round the tube, but the extremities of each slant obliquely downwards, so as to form a series of spiral curves rather than annular bands. This coat of the intestine exerts an important influence in the digestive function; the circular fibres, which are stronger throughout than the longitudinal, especially on the duodenum, must have the effect of constricting or compressing the canal, thereby intermingling its contents and urging them onwards to the cæcum, while the longitudinal fibres shorten the tube, and thus co-operate with the former by raising each successive convolution to receive the contents expelled from the preceding by the circular contraction. These actions follow each other gradually, but sometimes in rapid succession along the tube, and are commonly named the vermicular and peristaltic motions; the former are effected by the circular, the latter by the longitudinal fibres. The fibrous coat of the small intestine is analogous to that of the stomach. The mucous or internal coat is connected to the latter by vessels and nerves, and by a fine cellular tissue, which is sufficiently loose to admit of separation by the knife, or to be permeated by air and rendered emphysematous by the blow-pipe. This membrane is continuous with and very similar to that of the stomach in its general characters, but presents some peculiarities which deserve attention, one of the most important of which is the series of folds or duplicatures, named valvulæ conniventes; these are permanent processes or duplicatures of the membrane, and not effaced by distension, and therefore totally unlike the rugæ of the stomach, which are merely accidental foldings of the lining tunic seen only in the contracted or empty, and effaced during the distended state of the organ: the valvulæ conniventes should be inspected in a portion of recent intestine opened and suspended in water, or everted and then suspended, or in a section that has been inflated, dried, and opened. They commence in the vertical portion of the duodenum, at first few and small, but soon increase in number and size, and exist in the remainder of the duodenum, in the whole of the jejunum, and upper half of the ileum; they then again decrease in number and size, and are almost wholly absent in the last two or three feet of the ileum; they are best seen in the jejunum; they are semilunar folds or arches, extending round one-half or three-fourths of the tube perpendicular to its axis, broad in the middle, and narrow at the ends, which are often forked, and bend off obliquely, or end in vertical folds; they are nearly parallel, and in some places so close that the edge of one will reach the base of the next, but they never overlap; when the intestine is empty they lie flaccid, oblique, and vertical; rugæ are then also seen; but, when distended, they become extended into shelf-like partitions, not exactly parallel, but inclined a little obliquely downwards, and alternating with one another on opposite sides, so as to render the canal a sort of spiral tube or winding passage. A view of the dried preparation of these valves exhibits many of these characters very distinctly, but of course exaggerated as to strength and resistance, as they are naturally soft and flaccid, and can be folded in either direction, so that they cannot resist regurgitation, or act as true valves, like the pyloric or ileo-cæcal; each valve is composed of a fold of the lining membrane, inclosing nerves, bloodvessels, and absorbents; the convex and concave edge of each appears stronger than the intermediate portion, from the existence of a fine fibrous band, which is most distinctly developed in the duodenal folds; they are very unequal in size, seldom exceeding

a quarter of an inch, but are generally much smaller. They also vary much in different individuals, as also in different tribes of animals. These valves are of use in increasing the extent of a highly organized surface, and in delaying the food in its passage along the canal, thus affording to the absorbents a better opportunity to imbibe all the nutritious matter or chyle which it may contain; in proportion also as the intestine becomes distended, these valves become more tense, and project into the canal, so as to separate the food into smaller portions, and thus expose the entire mass to the action of the absorbents. The whole mucous surface of the small intestine is furnished with follicles and mucous glands; it also presents numerous projecting processes, called villi, which are very distinctly seen on a portion of the membrane everted and suspended in fluid, and which give to it a fine velvet-like appearance. The follicles of Lieberkühn are simple pouches of the membrane, very small, and scattered very numerously over the surface. They become very evident in enteritis, and are then filled with an opaque, whitish fluid; their openings can be seen with a lens; their cæcal ends rest in the submucous tissue; they generally surround the villi. The more elaborate intestinal glands present different appearances, and are known by the very inappropriate names of glandulæ Brunneri and glandulæ Peyeri, also glandulæ agminatæ, and solitariæ, or sparsæ. The glands of Brun are chiefly in the duodenum, in the submucous tissue, they surround the intestine in the form of a lamina of white bodies, each of the size of hemp-seeds; each consists of small lobules, the ducts opening into a common tube, and are very analogous to the pancreas and salivary glands, being of the same complex structure. They do not extend beyond the commencement of the duodenum. The glands of Peyer are sometimes collected into clusters (agminatæ), sometimes scattered separately in the lower part of the canal (solitariæ); the former are more properly the glandulæ Peyeri: in the healthy membrane they appear as small circular spots, white and slightly raised; over these there are few, if any, villi; the small openings of the follicles surround them; they are chiefly along the convex part of the intestine, and are sometimes seen distinctly by holding up a portion of the extended and semi-transparent surface between the eye and the light; no excretory duct can be seen, however, leading from these glandular patches, but on rupturing one of them it is found to contain a cavity filled with mucous and small vesicles or cells: it is supposed that at times an excretory duct opens from it and discharges the fluid of these cells or vesicles, or probably it has some communication with the adjacent follicles. Ulceration frequently destroys this investing membrane, and in such cases these glands appear as shallow, open ulcers. The use of these glands or bodies is unknown, as the nature of their secretion has not been ascertained; indeed the latter remark is applicable to the whole extent of the intestinal mucous membrane; the secretions which are produced from the different follicles and glands cannot be procured separately, or examined distinctly, nor can it be determined whether they should be regarded as accessory to digestion in the same way as the gastric, hepatic, and pancreatic fluids, or as excrementitous secretions, separating from the blood effete or noxious ingredients. We may, however, infer from the great extent of the surface, and from the abundance of secretion it affords, that any material alteration in its quantity must exercise an important influence on the general economy. The *villi* are those short cylindrical, or conical processes, seen on the mucous membrane in the small intestine, in some situations so numerous as to give to the surface a fleecy appearance; these little processes, when examined with magnifying powers, are found to be covered not only by epithelium, but also by a fine membrane, and to contain a minute plexus of bloodvessels, through the medium of which the absorption of fluids from the canal takes place: the lacteal vessels also commence in each villus by fine branches; but the most

accurate and trustworthy observers of the present day deny that they open on the surface by free orifices, as was formerly supposed and very generally described; and the same remark applies to the lymphatic vessels which arise in the various other tissues of the body. In each villus, near its extremity, the interstices between the capillary vessels are occupied, while chylous absorption is proceeding, by very small spherical vesicles or cells containing an opalescent fluid, and, where the vesicles approach the granular texture of the substance of the villus, minute granular or oily particles are seen. When the intestine contains no more chyme, the vesicles disappear almost entirely, the lacteals empty themselves, and the villi become flaccid; the epithelium, which had fallen off during the process of absorption, is then renewed. The vesicles at the ends of the villi may be regarded as cells whose lives are of short duration, selecting from the food the materials in contact with the villi, and appropriating these to their own growth, then liberating them by solution or disruption of the cell-wall in a situation where they can be absorbed by the lacteals. This power of selection is probably a peculiar vital endowment of the cells at the extremities of the villi rather than of the lacteals, and appears analogous to the property possessed by the different cells of plants, of selecting from the common pabulum the materials requisite for the elaboration of their own peculiar products, such as coloring matter, starch, oil, &c. From our present state of knowledge of the function of absorption, which, however, is by no means perfect, it appears reasonable to conclude that the nutritive material, or the chyle, which may be regarded as imperfectly-elaborated blood, is thus absorbed by the lacteals; and from the uniformity of its composition, notwithstanding the diversity of the food, that these vessels, or rather the cells, at the extremities of the villi, have the power of selecting the ingredients of which it is composed; whereas the veins only are concerned in the absorption of the fluids in the alimentary canal, these vessels being copiously distributed on the walls of the stomach and intestinal tube, and it is highly probable that the fluids are taken into them by the simple process of endosmose.—See Goodsir, Edinb. New Phil. Jour., July, 1842; and Carpenter's Human Physiol., p. 393.

Structure of the large Intestine.—This, in some situations, as has been already observed, is but partially covered by peritoneum: this membrane is more loosely connected to the transverse arch of the colon than it is to the small intestine, being unattached in two triangular spaces, one along the posterior concave border, between the laminæ of the meso-colon, the other along the anterior convex, between the layers of the great omentum; these favor its distension; it partially covers the cæcum, ascending and descending colon, but is variable in this respect; it surrounds the sigmoid flexure of the colon and the upper part of the rectum, as it does the small intestine; from the cæcum to the middle of the rectum it forms a number of processes, or *cul de sacs,* like omental, fatty appendices (append. epiploicæ), which vary very much in size and number; they often contain a great quantity of adeps; they diminish in size when the intestine is distended, and are elongated when it is contracted; they have been found so long as to have caused strangulation of an intestine, or to have been engaged in a hernia: in the child they exist, but instead of adeps they contain a reddish cellular tissue. The muscular coat of the large intestine also consists of longitudinal and circular fibres; the latter form a deep layer, pale and weak, and arranged as in the small intestine: the former, however, are collected into three fasciculi, all of which commence at the vermiform process, and pass along the cæcum and colon to the rectum; of these bands one is anterior on the cæcum; the others are posterior, one internal, the other external; they are about equidistant, and a quarter of an inch broad; they are white and strong, and possess considerable elasticity; that which is anterior on the cæcum, and on the ascending and descending colon, is some-

what inferior and anterior on the arch of the colon, and is inclosed between the laminæ of the great omentum; it is the strongest band; the posterior external band on the right and left colons and cæcum, is superior and posterior on the arch, and is between the laminæ of the meso-colon; the posterior internal on the lateral colons, is inferior on the arch, and is free and smooth. These two posterior bands usually unite into a broad and scattered lamina on the sigmoid flexure; they are all shorter than the tube itself nearly by one-half, and therefore produce the peculiar cellular or sacculated form, the pouches bulging out between the bands, and constricted by circular, muscular, and cellular cord-like fibres; the cells themselves being very thinly covered. If the intestine be inflated and extended, and then these longitudinal bands divided in different places, the tube will admit of extension to a considerable degree, and the pouches will be obliterated in the same proportion; scattered, short, longitudinal fibres, also, are occasionally observed along the course of the colon. On the rectum the muscular tunic increases in thickness, and resembles that of the œsophagus; the superficial or longitudinal lamina is continued from the bands of the colon, which have been previously expanding, but which now form a thick and perfect tunic, the vertical fasciculi of which are very obvious near the anus, where they also become confounded with those of the levator ani muscle of each side. Adipose substance is interposed between these and the peritoneum. The circular fibres also increase in strength and redness as we descend, and are collected into a thick annular fasciculus a little above the anus; this is termed the internal sphincter ani. The anal orifice is also furnished with a superficial or cutaneous sphincter, the anatomy of which, however, appertains to the perinæal region, in the examination of which, as well as of the pelvis, the rectum will again come under our notice. The internal or mucous coat of the large intestine is pale, and forms but few and imperfect folds. When distended and dried it presents internally several crests or semi-lunar ridges, separating the cells in the cæcum and colon, but these are formed by all the coats, except the longitudinal bands. This membrane has no villi, but when examined minutely presents the honeycomb or irregularly pitted appearance of the mucous membrane of the stomach, the pits or alveoli being studded with small foramina, the orifices of numerous follicles; it differs, therefore, very obviously from the lining of the small intestine, and this distinction is abruptly marked at the ileo-cæcal valves. In the vermiform appendix the follicles are large, close, and distinct; in the rectum the mucous membrane is more loosely connected to the muscular, particularly below, hence the frequency of its protrusion or eversion, in this situation also it is surrounded by numerous veins; in this intestine the mucous membrane is thrown into several longitudinal plicæ, as in the œsophagus; these are to admit of distension: it also presents some transverse or horizontal folds, one at its upper extremity, another about the middle, and the third lower down; this is the most regular, and extends from the anterior wall, opposite the lower fundus of the bladder; these folds are very distinct, in a distended and dried intestine; they are, however, by no means regular in number or size. Mr. Houston, who has particularly described them (Dublin Hosp. Reports, vol. v.) considers that they are sufficiently large and strong to support the fæcal mass, and thus to relieve the anus from its pressure; the mucous surface of the rectum, particularly below, is furnished with many follicles, some of considerable size, and with very distinct orifices.

We shall conclude this article with a few remarks on mucous membrane generally, our knowledge of the minute structure and functions of which has been considerably elucidated of late years by the assistance of the microscope. The term "mucous membrane" is applied to those great membranous expansions which are continued from the skin to line all the internal organs and the various glandular ducts and follicles; they form, in fact, the internal integument,

and, as they are always in contact more or less with extraneous matters, they are coated with a viscid secretion, termed mucus, which serves not only to defend their surface from contact, but also to lubricate the passage. The entire of the digestive and respiratory apparatus is lined by this structure, also the urinary and generative; these two great mucous surfaces are named, the former the gastro-pulmonary, the latter the genito-urinary; to the first our present remarks chiefly apply.

The gastro-pulmonary mucous membrane is continuous with the skin at the margins of the eyelids, nares, lips, and anus, lines the sinuses and recesses of the nose, the Eustachian tubes and tympana, covers the tongue, cheeks, palate, fauces, and pharynx, and at the lower part of the latter separates into two tubular prolongations; one, anterior, descends into the larynx, trachea, and bronchial tubes, into the cæcal terminations of which it is continued; the other, the posterior, lines the œsophagus, the stomach, and the entire alimentary canal, the pancreatic and biliary ducts and gall bladder, and the innumerable ducts and follicles that open upon this extensive surface. Although the appearance and character of this membrane vary in different situations, its structure being modified according to the function of each part, yet a general similarity in tissue prevails throughout. Mucous membrane is now considered as composed of three elements; first, the epithelium, which covers its free surface; second, the basement or papillary membrane, subjacent to the last; and third, the areolar tissue, which contains the nutrient and functional vessels and nerves, forms the principal portion of its bulk or substance, and serves to connect it to the surrounding tissues.

The epithelium bears some analogy, as to structure and use, to the cuticle or epidermis on the external integument, but presents considerable variety in different situations; in the mouth it consists of laminæ, composed of cytoblasts, cells, and polygonal scales; each cell and each scale has a central nucleus, within which are one or more nucleus corpuscles: the deepest lamina consists of cytoblasts only; in the next the investing cell or vesicle is developed; the cells by degrees become large and flattened, and in the superficial laminæ are converted into thin scales. The nuclei cells, and scales, are connected together by a glutinous substance containing opaque granules; the superficial scales exfoliate continually, and give place to the deeper layers: in the stomach and intestines these bodies are pyriform and columnar, the apices applied to the basement membrane, and the bases forming by their approximation the free surface. Each column has a central nucleus, and nucleus corpuscle, which can be seen through the base of the transparent column. The columnar epithelium is produced in the same manner as the laminated, in cytoblasts, cells, and columns, and the latter are continually thrown off to give place to successive layers. As it is always in contaet with fluids, it is soft and pliant, and, like the cutiele, it is constantly undergoing exfoliation and as constantly renewed: like it, also, it is composed of small nucleated cells, which are sometimes tessellated, sometimes cylindrical; the cells of the tessellated are polygonal, and composed of but few layers: those of the cylindrical have the form of long cylinders or truncated cones, arranged side by side, one end free, the other resting on the basement membrane. Both forms sometimes co-exist, as in the glandular ducts; and here also the eylinders are often ciliated, the motions of the cilia being towards the outlets of the canals they line. The cylinder epithelium is found in the stomach and intestinal canal, and in all the glandular duets opening upon these; also in those of the salivary glands. The epidermoid tissues have the simplest structure, and are the most easily renewed of any solid parts in the body; there appears no limit to their reproduction; their origin appears to be in germs supplied by the basement membrane, through which the formative plasma transudes; their duration varies in different parts; the epidermic cells, exposed on one side to the

air, soon dry, and are abraded gradually by friction or any other desquamating cause. On the internal serous surfaces, and in some few mucous, they are more permanent, but on most of the latter loss and renewal are almost incessant. The epithelial cells, on the mucous expansions and in the glandular ducts, are considered as the really operative agents in the elaboration of the mucous secretions; the cells are being continually cast off and replaced by fresh ones, and in this act of cell-growth the secreting process is accomplished. These cells of the tubes and follicles select from the blood those particles which it is their peculiar province to assimilate, and then discharge upon the surface; but we are totally ignorant of the reason why, in one situation, cells should select one peculiar set of elements, and, in another, another, and thus produce from each organ a different secretion; all that can be considered as ascertained is, that the act of secretion is effected by the process of cell-growth, and that secretion and nutrition, or growth, appear to be analogous functions, or to be effected by analogous agencies, for as the cells in the extremities of the villi select from the alimentary mass the nutritious particles which are to be absorbed, so the cells of the secreting ducts and follicles select from the blood those effete particles which it is their province to assimilate and discharge upon the surface of those canals whereby they will be removed from the system.—See Nasmyth's Mem. on the Teeth and Epithelium; also Muc. Memb. in Todd's Cyclopædia of Anatomy and Phys., by Bowman.

The second lamina of mucous membrane is by some named "the basement membrane," by others "the papillary layer;" from it is produced the epithelium; its surface presents different appearances in different situations; in the stomach it forms the cells or alveoli into which the follicles open; in the small intestine, it covers the numerous projections called villi, and in the large intestine again it presents polygonal cells like those in the stomach.

The third element in mucous membrane is the fibrous lamina which gives it support, strength, and form, and so far is analogous to the corium in the skin, but seldom equals it in density; it is also more loosely connected to the proper mucous lamina than the corium is to the papillary layer of the skin; it is chiefly composed of areolar tissue, in which the white and yellow fibrous elements can be detected; these connect it to the sub-mucous tissue, from which indeed it cannot be separated as a distinct lamina; it contains the capillary bloodvessels, nerves, and absorbents.

The *peritoneum* and alimentary canal present many *morbid* appearances. *Peritonitis*, or inflammation of the peritoneum, is denoted by an increased and a reddish vascularity of the membrane, a number of small red vessels can be distinctly seen; it loses its transparency, and becomes somewhat thick and pulpy; the parietal and visceral layers are sometimes found agglutinated by coagulable lymph, which also cements the several intestinal convolutions, but sometimes the cavity is filled with serous or sero-purulent fluid, with shreds of lymph; peritonitis more frequently ends in some such effusion than in the adhesive process; the contrary is more frequent in pleuritis; peritonitis also sometimes exhibits gangrenous patches, but if it have been chronic, adhesive bands and false membranes are very apparent. In *ascites* or dropsy of this membrane, the tissue of the latter appears sound, sometimes remarkably clear or pearly; the intestines are usually compressed towards the spine, the fluid being accumulated in front; in this disease some of the viscera, particularly the liver, are often found in an abnormal state.

The *omentum* is sometimes the seat of general induration, or of particular tumors, adipose, sarcomatous, and fungoid. The omenta and the peritoneum generally, but especially where it invests the small intestines, are not unfrequently the seat of tubercular deposit; the tubercles are often small, or miliary and innumerable. This morbid appearance is more frequently found in very young subjects.

The *stomach* may be the seat of acute inflammation, or *gastritis;* the coats will then appear more thick and vascular than usual, and blood is sometimes seen effused between them. *Ulcers* also are frequently found in the stomach, of an oval or circular form, with thin and firm edges. Independent of disease, the stomach not unfrequently presents considerable red patches on its mucous surface; the coats are also sometimes nearly destroyed in some places, presenting a soft and ragged appearance; this is caused by the gastric fluid digesting or dissolving the tissue after death. Both the cardiac and pyloric ends of the stomach are the frequent seat of *cancer;* this principally involves the mucous or muscular tissues; the latter becomes much thickened and intersected with gray, fibrous matter. On the former large fungoid masses are thrown out, which more or less constrict or obstruct the orifices of the organ, and impair its general functions.

The *intestinal tube* is subject to numerous diseases, in most of which the effects of inflammation are more or less visible: inflammation, or *enteritis,* is denoted by increased vascularity of the mucous surface and thickening of the tunics; in some cases the peritoneum is also engaged; the color of the intestine is a deep or dark red; acute inflammation sometimes ends in gangrene and effusion, sometimes in ulceration. The whole of the intestinal surface may be the seat of ulceration; in the small intestines the ulcers are generally small, and are often found in the situation of the mucous glands; in the large intestines they are usually in larger patches, and in cases of dysentery are often very extensive. The intestinal tunics are occasionally the seat of malignant tubercle, which may obstruct the course of the contents of the tube; of all parts of the intestinal canal the rectum is most frequently the seat of scirrhus and its consequences.

The glandular viscera of the abdomen, which are subservient to digestion, are the liver, spleen, and pancreas.

The *liver* is the largest and heaviest secreting gland in the body: it fills the right hypochondrium, extends through the anterior part of the epigastric region into the left hypochondrium, as far as the cardiac orifice of the stomach, beyond which, however, it frequently extends, even to the spleen; it is situated below the diaphragm, and above the right kidney, the stomach, duodenum, and lesser omentum; is protected by the seven or eight lower ribs of the right side, and is supported in this situation by several folds of peritoneum, termed inaccurately ligaments of the liver, viz., the falciform, round, right, left, and coronary; these connect it to the diaphragm and to the abdominal muscles, and the lesser omentum attaches it to the stomach and duodenum; the inferior cava passes through it, is intimately attached to it, and also serves to retain it in its situation. Although the liver may be considered as a fixed viscus, its position can be affected by change of posture, by inspiration and expiration, and by abnormal conditions of the viscera of the abdomen, or of the thorax. Its weight, size, and figure, are extremely variable, and consequently its position and extent must vary in proportion; its weight varies from three to five pounds, and must in some measure depend on the quantity of blood it contains; its transverse diameter is the longest, and is about ten or twelve inches; the vertical diameter in the deepest part of the right lobe is about seven inches, but these dimensions are very variable; it is in general larger in the male than in the female.

The *suspensory* or *falciform ligament* is a fold of peritoneum attached anteriorly by its convex border to the linea alba, to the rectus muscle of the right side, and to the diaphragm; it passes obliquely backwards and to the right side, and is attached by its posterior or concave edge to the upper or convex surface of the liver, which it thus marks into two unequal portions, of which the right is the larger; on these its laminæ separate, and expand over each side of this organ; inclosed in the inferior edge of this fold is the obliterated

umbilical vein, which substance in the adult is named the *ligamentum teres;* this, which is enumerated as the second ligament of the liver, ascends from the umbilicus obliquely backwards, and to the right side, and is inserted into a notch, in the thin or anterior edge of the liver, which notch is the commencement of the umbilica or horizontal fissure of the liver. The falciform or suspensory ligament is improperly so called; it cannot have the effect of supporting this organ, as it is never on the stretch. If the abdomen were much distended, it might sustain the anterior surface and the inferior margin of the liver. The use or design of this fold was clearly to conduct and protect the umbilical vein in fœtal life. The *right* and *left lateral* ligaments are triangular folds, connecting the right and left lobes of the liver to the diaphragm: the left lateral ligament lies anterior to the cardiac orifice of the stomach; the right lateral ligament is directly above the right kidney. The left is much broader and more distinct; between its laminæ are observed plexures of vessels derived from those of the gland; if minutely injected, the hepatic ducts may be seen dividing and subdividing, anastomosing with each other, and entangled, among hepatic arteries, some portal and hepatic veins; displaying, in fact, the simple or rudimental structure of the liver. The *coronary ligament* is situated at the upper extremity of the falciform process, and consists of two laminæ of peritoneum, which separate from each other, and connect the superior thick edge of the liver to the diaphragm; between the laminæ of this process the liver is deprived of a serous covering, and is in contact with the diaphragm; this space lies anterior to the inferior vena cava; in it a cellulo-vascular and nervous connection exists between this and other organs, which accounts for some phenomena in disease; thus irritation, inflammation, and chronic disease in the liver may stimulate disease of the right pleura or lung, as these and the diaphragm are so contiguous; and the action of the muscle in inspiration will increase the pain and uneasiness in the right side. The origin, connection, and terminations of the phrenic nerve account for the uneasiness and pain in the right shoulder and scapular region. Abscess of the liver may open into the right pleura, and cause empyema; or it may, by the adhesive and ulcerative processes, open into and be discharged through the right bronchial tubes, &c., &c.

The liver is of such an irregular form that it cannot be likened to any known figure; it is longer transversely than from before backwards, and its right extremity is so much larger and thicker than the left, which often ends in a sort of tongue or thin prolongation, as to give some resemblance to a flattened oval or a pyramid, the base filling up and moulded to the right hypochondrium, the apex thin, and of an irregular extent, often passing the cardia and touching the spleen; its posterior edge is very thick, and in contact with the diaphragm; its anterior edge is thin, convex, and on a level with the edge of the right hypochondrium and with the lower part of the epigastric region. Two notches may be observed in this edge; one below the falciform ligament, into which the round ligament or obliterated umbilical vein enters, the other corresponds to the gall bladder.

The superior or anterior surface is smooth and convex, and divided by the suspensory ligament into a right and left portion; the right is larger and much more convex than the left, is contiguous to the diaphragm, and corresponds to the seven or eight inferior ribs, which often make impressions upon its surface, particularly if the organ be very large; the upper part of its surface is occasionally grooved or fluted, apparently by corresponding fasciculi of the diaphragm; the left portion corresponds to the abdominal parietes in the epigastrium, and in the normal state descends no further than a transverse line connecting the eight ribs of the opposite sides; in the fœtus and infant it extends much lower, and very frequently also in the adult.

The inferior surface has an aspect backwards and downwards; it is very

irregular, marked by several projections and depressions; the former are called *lobes*, and are five in number, viz.: first, the *great* or *right lobe*, which fills the right hypochondrium, and is thick and massy; second, the *left*, thin and variable in size, separated from the former by the horizontal fissure on this surface, and by the falciform fold on the upper; this lobe occupies the epigastrium and part of the left hypochondrium, and rests on the stomach; third, the *Spigelian* or *middle lobe;* this is situated behind the lesser omentum, above and behind the transverse fissure, and between the œsophagus and the cava; it corresponds to the lesser curvature of the stomach, and projects into the upper part of the sac of the omentum, towards the head of the pancreas; the transverse fissure bounds it in front, the thick margin of the liver behind, the groove for the ductus venosus on the left side, and that for the vena cava on the right; it is very variable in size and extent; it has a mamillary form, the smooth and convex apex below embraced by the branches of the cæliac axis of arteries; it is connected to the right lobe by two roots; one is thin, and placed vertically between the fissure for the vena cava and that for the ductus venosus; the other is thick, and placed transversely, and is called *lobulus caudatus*, or the fourth lobe, of the liver; the lobulus caudatus is immediately behind the transverse fissure, and in front of that for the inferior cava, and extends from the Spigelian obliquely outwards and forwards along the right lobe between the depressions marked by the colon and right kidney. Fifth, the *lobulus quadratus*, or *anonymus*, is at the anterior part of the right lobe, in front of the transverse fissure, and between the gall bladder and horizontal fissure; its posterior border is sometimes so prominent as to have led to the name of the anterior portal eminence, as the Spigelian and caudatus lobes have been called the posterior.

The principal depressions or fissures on the inferior surface of the liver are the following: first, the *transverse fissure*, or *porta*, which is situated between the lobulus quadratus and caudatus, and extends from the horizontal fissure transversely to the right; it is very broad, and nearly two inches in length; it is about the centre of the organ, but a little nearer to the posterior edge than to the anterior, and to the left than to the right extremity; the horizontal fissure bounds it on the left and communicates with it, and thus marks the course of the inosculation during fœtal life between the umbilical and portal veins; the lesser omentum is attached to its margins; the sinus and the two great branches of the vena porta, the hepatic artery and duct, lymphatic vessels and nerves, and much cellular tissue, occupy this depression. Second, the *horizontal fissure* extends from the notch in the anterior edge of the liver backwards and upwards between the right and left lobes; the anterior part of this fissure contains the fibrous remains of the obliterated umbilical vein, the posterior part those of the obliterated ductus venosus. The anterior half is deeper than the posterior, and is often converted into a complete tube by a transverse bridge of glandular or fibrous tissue; the posterior half leads obliquely to the left of the Spigelian lobe, and communicates with the termination of the groove for the vena cava, and thus marks the course of the inosculation in fœtal life between the ductus venosus and the inferior cava, or rather one of the hepatic veins close to that trunk. Third, the *fissure for the vena cava* is between the lobulus Spigelii and the right lobe; this, like the anterior part of the horizontal fissure, is frequently converted into a tube by a fibrous or glandular band. Fourth, *the depression of the gall bladder* is on the inferior surface of the right lobe, and to the right side of the lobulus quadratus; the substance of the liver is sometimes deficient over this bag. Fifth and sixth, *superficial depressions* on the under surface of the right lobe; the anterior corresponds to the *colon*, the posterior to the *right kidney* and its capsule. These depressions are indistinctly marked in some subjects; they are separated from each other by the extremity of the

lobulus caudatus. Seventh, a superficial depression on the under surface of the left lobe, corresponding to the anterior surface of the stomach. Eighth, a broad notch in the posterior edge of the liver, corresponding to the spine and to the right crus of the diaphragm; the venæ cavæ hepaticæ leave the liver in this situation. The five principal fissures, namely, the horizontal and transverse, with those for the vena cava and gall bladder, have been resembled to the letter H; the left limb being the umbilical fissure anteriorly, and that for the ductus venosus posteriorly; the right limb, the groove for the gall bladder in front, and that for the vena cava behind, while the transverse fissure is the connecting bar. It is obvious that these five fissures are concerned in marking the divisions into the five lobes; the distinctions, however, between these are merely accidental, and are only superficial, and do not exist on the upper surface, so that, strictly speaking, this great conglomerate gland is but one mass or lobe. The *circumference* of the liver presents anteriorly and inferiorly a thin, sharp edge, leading from the right side obliquely upwards and to the left; on the right this edge corresponds to the border of the thorax, and looks forwards and downwards; on it are two notches; one, very deep, leads into the horizontal fissure, and receives the fibrous remains of the umbilical vein; the other is to the right side of this, corresponds to the base of the gall bladder, and varies in extent and depth. The greater portion of this margin of the liver can be felt during life, when the abdominal parietes are in a relaxed position. The right extremity of the circumference is thick, round, and smooth, and attached by the right lateral fold or ligament; the left extremity is thin and elongated to a variable extent; the broad left lateral ligament fixes it to the diaphragm. The posterior part of the circumference is round, and thicker on the right side than on the left, adheres to the diaphragm by cellular tissue within the laminæ of the coronary fold or ligament, and presents the deep and broad notch to correspond to the right crus of that muscle and to the spinal column. The groove for the vena cava terminates at this notch, and the large hepatic veins escape from the liver, and join that trunk.

The liver is of a peculiar brown color, interspersed with yellow; in some subjects it is much darker than in others; in the very young it is red and soft, and in the old it is generally pale and yellow, and often hard and brittle; the tints and shades are of infinite variety, dark red, deep purple, brown chocolate, green, slate, pale yellow, gray, and even white; all these depend on different degrees of congestion, either venous or biliary, and there is no valid reason for attributing them to two differently colored tissues in the liver, the red and the yellow, as was considered to be the case by some. The consistence of the liver, like the color, is very variable, even in the absence of actual disease; it is usually dense, firm, and resisting to the feel, but sometimes it is very compact, and even hard, the edges, particularly, brittle or friable; in such cases it may be torn or broken, and the fractured surfaces will present a granular texture; in other cases it is so soft as to retain the impression of the finger, or to break down under the slightest pressure; in such instances, however, there is often a fatty degeneration of the organ.

The liver has two coats, a serous and fibrous: the serous or peritonæal tunic covers the whole surface of the liver, except in those situations where the vessels, either pervious or obliterated. are situated, and between the laminæ of the coronary ligament, also the depression in which the gall bladder is lodged; this tunic is very thin, and adheres intimately to the fibrous capsule; it gives support and connection to the granules or lobules of the gland, and allows it and the adjacent parts to glide smoothly on each other.

The second, or fibrous coat, is the immediate capsule to the gland; it is thin, little more than condensed cellular membrane; it is most distinct and strong where the serous coat is deficient; it covers the whole surface of the

liver, and adheres to it by innumerable shreds or processes, which pass into its substance between the granules, and forms a capsule for each lobule; it also accompanies the three vessels of the liver which enter or leave the transverse fissure, and forms a capsule or sheath around their ramifications throughout the entire organ; this sheath receives the name of the *capsule of Glisson;* its processes or sheaths surround the vessels very loosely, as they also inclose loose cellular tissue; externally these sheaths adhere to the lobules of the liver, as each sends off numerous processes to inclose the several granules similarly to these derived from the surface; there is also an inflection of this tissue at the upper part of the liver, where the venæ cavæ hepaticæ escape, but it contains no loose cellular tissue; hence it is that if the three sets of vessels, which pass from the transverse fissure in a radiated direction through the organ, from the centre towards the circumference, be divided by a perpendicular incision through the liver, they will be found to collapse and recede; whereas, if the venæ cavæ hepaticæ, which run from the thin towards the thick edge of the liver, be divided by a transverse incision through this organ, they will not recede or collapse, but remain perfectly open, in consequence of the absence of this cellular tissue, and of their close adhesion to this membranous tube, to which the substance of the gland intimately adheres. This structure may be considered as the basis or foundation of the whole organ, forming not only a general covering for its surface, but for each of the granules of which it is composed, while it is also continued from the transverse fissure around the vena porta, hepatic artery, and biliary ducts, to form sheaths for these vessels, even to their ultimate ramifications. This capsule, though generally regarded as fibrous tissue, yet is really "a cellulo-vascular membrane in which the vessels divide with great minuteness; it lines the portal canals, enters the interlobular fissures, and forms capsules for the lobules, and expands over the secreting biliary ducts;" it commences in front of the spine, accompanies the hepatic vessels through the lesser omentum, and then through the organ, in the substance of which it may be divided into three portions, the vaginal, the interlobular, and the lobular. The *vaginal* portion surrounds the hepatic artery and duct, and the vena porta in the portal canals; the *interlobular* portion fills the interlobular fissures and spaces; and the *lobular* portion supports the tissue of the lobules, and forms a capsule for each.

The structure of the liver consists of numerous small granulations or lobules of a brown and yellow color, connected together by the branches of the hepatic arteries and veins, and of the vena porta and biliary ducts, and by lymphatics and nerves, the whole of which are cemented together by Glisson's capsule, or the tunic just described. The arrangement of these several tissues has been admirably made out by Mr. Kiernan, and described by him in his excellent memoir published in the Phil. Trans. for the year 1833. To his account of this organ little can be added, and I therefore confidently refer the reader to his description of it. Although the surface of the liver is generally so smooth and compact as to appear one homogeneous structure, yet if its coats be removed, or if a portion of the gland be broken or torn, the surface presents an irregular aspect, rugged and granulated, evidently showing that this organ is composed of numerous minute bodies or grains closely connected together; these, which are termed lobules, together with the ramifications of the vena porta, biliary ducts, hepatic artery and veins, lymphatics and nerves, all of which are cemented together by the fibro-cellulo-vascular tissue, or Glisson's capsule, constitute the mass of this very large conglomerate gland. On each of these we shall offer a few remarks.

The *lobules* are small granules, of the size of millet seeds, but of irregular forms, rounded, and with angular prominences; each presents a base which rests upon an hepatic vein, which is therefore called sublobular vein, the remainder of this lobule is invested with a capsule from Glisson's membrane;

this surface is connected to the capsular surfaces of the adjacent lobules; the intervals between these lobules are called interlobular fissures, and the angular spaces formed by the apposition of several of these lobules are called interlobular spaces. The lobules on the surface are larger and more flattened than those which are internal. Each lobule is composed of a plexus of biliary ducts, of a portal venous plexus, of an interlobular branch of an hepatic vein, and of minute arteries; nerves and absorbents cannot be traced, but may be presumed to exist in each. The microscope exhibits the lobule as composed of numerous minute yellowish bodies, of various forms, and connected together by vessels; these minute bodies are the acina of Malpighi, and they are probably the cæcal extremities or plexiform terminations of the biliary ducts: each lobule may be regarded as a very minute though a perfect gland, and the whole liver is but the aggregation and close union of these.

Through the liver *four* sets of vessels ramify, in addition to numerous lymphatics, viz., the branches of the hepatic arteries, venæ portarum, hepatic ducts, and hepatic veins; the venæ portarum are supposed to be the vessels from which the bile is secreted; the hepatic arteries nourish the substance of the liver, and join the vena portal plexus; the hepatic ducts carry the bile from this organ, and the venæ cavæ hepaticæ return the blood which has circulated through the liver to the inferior vena cava, just as this vessel is passing through the diaphragm.

The *vena porta* is a very large, a very important and peculiar vessel; though it arises in the abdomen as a vein, and serves the same office, yet in the liver it terminates as an artery, and has a secreting function; it returns the blood from all the chylopoietic viscera to be distributed through the liver, and in the latter organ it receives the venous blood from the terminations of the hepatic artery. It is four or five inches long, is formed by the confluence of the splenic and mesenteric veins behind the pancreas, in front of the aorta and to the left of the inferior cava; it ascends obliquely to the right side, receiving branches from the pancreas, duodenum, stomach, and gall-bladder, inclosed in and conducted by the lesser omentum to the transverse fissure of the liver, the left extremity of which it enters, and then divides into a right and left branch; these separate so widely as to form a short trunk or swell at right angles with the vein itself (sinus of the porta), then enter the liver, divide and subdivide into numerous branches, which radiate towards the circumference in horizontal directions, and lodged in canals, termed the portal canals, which are formed of the vaginal processes of the capsule of Glisson, and, like the superficies of the organ, by the capsular surfaces of the lobules. Each of these canals contains a portal vein and its branches, also an artery and a duct; in the large canals these vessels are surrounded more loosely by the capsule, but in the smaller canals the parietes are in close contact with the vein on one side, and with the artery and duct on the other. The branches of the vein are the vaginal, interlobular, and lobular. The *vaginal* arise in the portal canals, pass into the sheath formed by Glisson's capsule, and form in it the vaginal plexus. The *interlobular* branches arise from the vaginal plexus, enter the interlobular spaces, and divide into branches which cover all sides of the lobules, except their bases on their peritonæal surface; these branches form a free communication through the entire organ. The *lobular* branches arise from the last, enter and form a plexus in each lobule, and end in a minute intralobular vein; this may be called the lobular venous plexus, and is between the interlobular portal veins and intralobular hepatic veins. In the meshes of this plexus are seen, by means of the microscope, the acini of Malpighi, or portions of the lobular biliary plexus. The capsular veins of the liver not only join the porta, but also inosculate with the phrenic veins. In some cases of atrophy of the liver and obstructed circulation of the blood, collateral circulation has been main-

tained by the anastomoses between these veins, as also between the capsular branches of the hepatic artery and the phrenic and others. The *hepatic artery* is a branch of the cœliac axis; it ascends in the lesser omentum to the left side of the bile duct, and in front of the vena porta enters the liver with this vein and with the hepatic ducts, pursues the same course, and divides into the corresponding branches, vaginal, interlobular, and lobular. The *vaginal* branches form a vaginal plexus; the *interlobular* ramify in the interlobular fissures, and are chiefly distributed to the coats of the biliary ducts; small branches also ramify in the capsule of the liver and anastomose with branches from the phrenic, internal mammary, and suprarenal arteries. The *lobular* branches are very small and few; they are the nutrient vessels of the lobule, and end in the lobular venous plexus of the vena porta. Kiernan maintains the opinion, and adduces strong evidence in its support, that the office of this artery is nutrient, and not secreting; minute injections of it color very highly the cellular tissue and the coats of the ducts and of the other vessels, as also the gall bladder, but produce very little effect on the lobules themselves. The terminating branches of this artery have no communication with the hepatic veins, but all join the lobular venous plexus of the porta, which is the secreting agent; the intralobular veins, which are the radicles of the hepatic veins, receive the blood, not from the arterial capillaries, but from the lobular venous plexus. The *hepatic ducts* may be traced from the transverse fissure along with the last-mentioned vessels, and present the same order of branches, vaginal, interlobular, and lobular; the first form a vaginal biliary plexus, from which proceed the interlobular, which ramify on the capsular surface of the lobules, and freely communicate with each other: the lobular ducts proceed from these, some also from the vaginal plexus; these enter the lobule, and form within it the lobular biliary plexus, in which the ducts end either in cæcal extremities, or in anastomosing arches. The coats of the ducts are very vascular; they possess many mucous follicles; these are distributed irregularly in the large ducts, but are arranged in two longitudinal and parallel rows in the smaller.

Hepatic veins convey the blood from all parts of the liver to the vena cava; they are also divisible into the three orders; intralobular, sublobular, and hepatic trunks. The *intralobular* pass through the central axis of the lobule and through the centre of its base, and end in the sublobular veins. The *sublobular* veins are lodged in canals formed by the bases of the lobules, and are in close contact with the latter without the intervention of any of Glisson's capsule; they are thin and transparent, and, if laid open, the bases of the lobules will be distinctly seen, separated by the interlobular fissures, and perforated in the centre by the intralobular vein. The hepatic veins are formed by the union of the sublobular veins; they are lodged in canals lined by the capsule of the liver, but not surrounded by cellular tissue or vaginal plexus; they all proceed from before and from below upwards and backwards, and end in two or three large trunks, which open into the cava close to the diaphragm: in this course they cross the branches of the porta which radiate from the centre towards the margins of the liver. When cut at right angles they remain open, and retain their cylindrical form, as they are closely connected to the lining of the hepatic canals in which they are lodged; no other vessel is inclosed with them, whereas every branch of the vena porta is accompanied by a small artery and bile duct, and the three are enveloped in the capsule of Glisson. The *right* and *left hepatic ducts* are nearly of equal size, and, on clearing the transverse fissure, unite at an obtuse angle, and form the *hepatic duct*, which descends for about one inch and a half along the right side of the lesser omentum, is then joined at an acute angle by the cystic duct, from the gall bladder: the union of these forms the *ductus communus choledochus;* or rather the hepatic duct may be said to give off the

cystic, which, passing backwards and to the right side, dilates so as to form the gall bladder, and the ductus choledochus may then be regarded as the continued hepatic duct. This vessel, about three or three-and-a-half inches long, descends obliquely backwards, at first in the lesser omentum, in front of the vena porta, and to the right of the hepatic artery; then it passes behind the pylorus, the upper part of the duodenum and the pancreas, and is imbedded in the substance of the latter; about the middle of the internal or concave side of the middle division of the duodenum it perforates the coats of this intestine in a very oblique direction, and opens on a small papilla internally, opposite the lower angle of the duodenum: as the ductus choledochus is about to perforate the duodenum, it is in general joined on the left side by the duct from the pancreas.

The lymphatic vessels of the liver are very numerous, and are arranged into a superficial and deep set; the former present a network appearance beneath the peritoneum, often very distinct; the latter are larger, escape by the transverse fissure, enter the lesser omentum, and end some in the adjacent lymphatic glands, and others in the thoracic duct.

The nerves are small; a few from the pneumogastric, and probably some fine filaments from the right phrenic; but the principal supply is from the solar plexus; these form a plexus around the hepatic artery, and some also around the vena porta, and accompany these vessels as far as the eye can trace them.

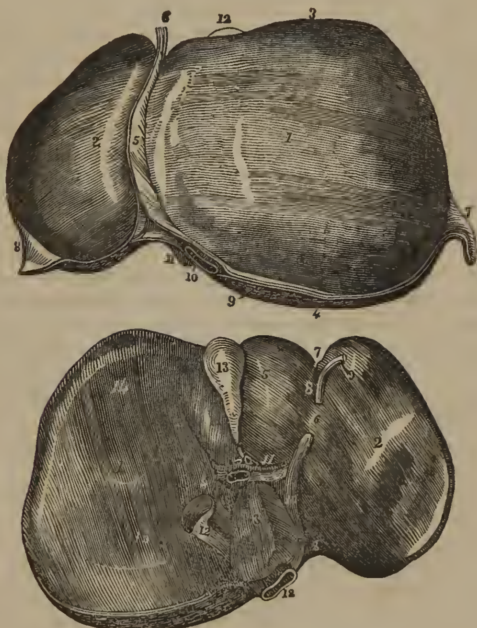
The *gall bladder* is of very variable size, is situated in the right hypochondrium in a depression on the inferior surface of the right lobe of the liver, between the right extremity of the transverse fissure and its anterior margin, and to the right side of the lobulus quadratus; this membranous sac is of a pyriform figure; the large extremity or fundus being directed forwards and downwards, and to the right; in some it projects below the liver against the abdominal muscles, opposite the outer border of the right rectus muscle, and the cartilages of the ninth and tenth ribs; it is generally contiguous to the pylorus and to the colon; the smaller extremity or neck is directed upwards, backwards, and to the left; is a little convoluted, and ends in the *cystic duct*, which is about an inch and a half long: this duct bends downwards and inwards, and joins the hepatic duct at an acute angle, the union with which forms, as was before mentioned, the ductus choledochus. The gall bladder is closely united to the liver by the peritoneum, which passes over it; also by cellular membrane and small bloodvessels; it is composed of three coats: a serous, which is only partial, a perfect cellulo-fibrous coat, and a lining mucous membrane; the latter has a peculiar honeycomb-like appearance, and in the duct is disposed in a spiral valvular lamina; there is no appearance of a muscular coat.

This viscus serves as a reservoir for the bile, when this fluid is not required in the intestinal canal; and that its office is but secondary may be inferred from its absence in many animals; it is wanting in all invertebrata; the biliary ducts in these open on the surface of the digestive organ. In fishes it first appears, but is absent in many genera, and rudimentary in others, as a mere dilatation of the bile duct. It exists in all the reptilia; in the ophidia it lies at a distance from the liver, and has therefore a very long cystic duct; in the chelonia it is buried in the substance of the organ, and receives the bile by hepato-cystic ducts. In many birds it is absent, and in many it is present; in the latter the bile is brought to it from the liver by an hepato-cystic duct; the hepatic opens into the duodenum near the cystic; there is no choledochus duct. In mammalia it is very uncertain; it is absent in most herbivora, as horse, elephant, stag, but is present in many, as ox, sheep, and goat; in one giraffe it was wanting, in another it was double. The hepatic, cystic, and choledochus ducts are all composed of similar tissues, viz., a fine lining mu-

cous membrane, thin and follicular, continuous with that of the duodenum and the gall bladder; a middle, fibrous, and areolar texture, which most probably possesses some contractile property, and are external, cellular, and partial peritonæal covering; they are all thin and very dilatable; the latter property is exemplified throughout the whole series when the flow of bile is arrested by any obstruction at the duodenal extremity of the ductus choledochus.

The bile is secreted in the liver, flows down the hepatic duct, and, if not required in the duodenum, or if obstructed in the ductus choledochus, passes into the cystic duct to the gall bladder, where it remains a longer or shorter period, during which some of its watery part is absorbed; at the end of some time, when required to assist in digestion, it is forced out of the gall bladder, and then flows again along the same cystic duct to the ductus choledochus, and so to the duodenum. The bile is not secreted in the gall bladder, nor can it possibly enter or leave this viscus by any other channel than through

Fig. 47.*



* The superior surface of the liver. 1. The right lobe. 2. The left lobe. 3. The anterior thin edge. 4. The posterior thick edge. 5. The suspensory or falciform ligament. 6. The ligamentum teres. 7. The right lateral ligament. 8. The left lateral ligament. 9. The portion of the thick border of the liver which is uncovered by the peritoneum and surrounded by the coronary ligament. 10. The inferior vena cava cut across. 11. The posterior extremity of the Spigelian lobe. 12. The fundus of the gall bladder, projecting beyond the anterior edge of the liver.

The inferior surface of the liver. 1. The right lobe. 2. The left lobe. 3. The Spigelian or middle lobe. 4. The lobulus caudatus. 5. The lobulus quadratus. 6. The pons hepatis, not always present. 7. The notch in the anterior edge of the liver, forming the commencement of 8. 8. The horizontal fissure. 9. The obliterated umbilical vein. 10. The obliterated ductus venosus. 11. The transverse fissure. 12. 12. The vena cava inferior. 13. The gall bladder. 14. A superficial depression corresponding to the colon. 15. A similar one corresponding to the right kidney and supra renal capsule.

the cystic duct, as there are no hepato-cystic vessels, as in reptiles and in some birds.

The office or *use* of the liver is to secrete the bile; it is most probable also that it exerts an important influence in sanguification, or in the purification of the blood. The secretion takes place in the lobules from the great venous plexus of the portal vein, and as the blood of the hepatic artery has become venous previous to its passage into the lobular venous plexus, this secretion must be wholly from venous blood; the elements which are thus separated from the venous blood of the chylopoietic viscera, and which constitute the bile, are useful in digestion, and are supposed to act chemically on the chyme in the duodenum, and to produce the separation of the chyle; the bile also combines with the residual or fæcal matter, to which it imparts its peculiar coloring matter, and it also stimulates the mucous surface of the intestinal tube to pour forth its secretions, and the muscular coat to contract upon its contents. That the liver also exerts some additional function in depurating the blood, may be inferred from the great size of this organ compared with that of its excretory apparatus; the considerable magnitude of it in fœtal life, when the biliary secretion is scanty and not required in digestion; the large venous system that is expanded through it; the proportion it bears inversely to the lungs, but directly to the necessity for removing from the blood a larger quantity of hydrogen and carbon; in the herbivorous animals, in the quadrumana, and in man, it is not so large as in the carnivora; in birds it is larger, as there is great need of highly oxygenated blood; in fish and in reptiles, with cold blood and imperfect respiration, it is still larger; it is also very large in the invertebrata.

No viscus in the abdomen presents such frequent and varied abnormal appearances as the liver. The pathology of many of these has been much elucidated by the anatomical and physiological researches of Kiernan.

Inflammation, acute or chronic, of its peritonæal coat, or *membranous hepatitis*, is marked by the usual characters of serous inflammation. The capillaries are injected with blood and coagulable lymph is effused, agglutinating the adjacent parts; adhesions more frequently occur on its convex than concave surface. This condition may exist independently of inflammation of the organ itself, though some congestion in the latter is commonly present.

The mucous lining of its excretory vessels may also be in a state of acute or chronic inflammation, caused by extension of irritation from the mucous membrane of the gall bladder, duodenum, or alimentary canal. This induces thickening, contraction, and partial obliteration of the ducts, and may thus become the source of many chronic diseases of the liver, and abnormal changes in its tissue.

Hepatitis, or acute inflammation of its parenchyma, is seldom seen in the dead body; it is denoted by a deep red or purple color, a firm and heavy feel, and some increase in size; the investing membranes are easily detached, and the subjacent surface is very granular and vascular. Hepatitis often ends in suppuration; the pus may be collected in several small cysts through the liver, or diffused among its lobules, or it may be collected into one large abscess, the contents of which may be discharged in various directions, and recovery ensue. Adhesive inflammation attaches its walls to the surrounding parts, or to some adjacent viscus, and ulceration gives exit to its contents without any effusion into the abdomen. By this process an hepatic abscess may point, and be opened by the surgeon through the abdominal parietes, or between the ribs, or it may burst into the pleura, or by the continuation of the same adhesive process, it may become attached to the lung, and the matter may escape into the bronchial tubes, and be coughed up, or it may open into the stomach, or duodenum, or colon, and be discharged through the alimentary canal; it has also been known to have opened into the pericardium

and into the vena cava. The liver, containing an extensive venous expansion, is frequently the seat of abscess, in consequence of injuries of the head, or of the bones, or of wounds, or operations in any part of the body in which phlebitis has occurred. From a number of observations and ingenious experiments, Cruveilhier has concluded that in all these cases there has been a capillary phlebitis in the part injured, and that the globules of pus carried thence to the lungs and liver have produced irritation and suppuration in these organs. In all such cases of hepatic suppuration he has found similar purulent deposits in the lungs; in all visceral abscesses from this cause we find around the inflamed veins induration, effusion of blood, lymph, and pus; the latter also is found in the minute veins, and, when in the liver, diffused among the lobules, producing a sort of granite-like appearance.

Venous congestion in the liver is very frequently seen in the dead body, and is to be considered rather as an effect depending on the abnormal state of some other organ or function than as a disease of this organ itself; congestion may be partial or general, and it may be in the hepatic venous system, or in the portal. In hepatic venous congestion, the hepatic veins, their intralobular branches, and the central portions of their lobular plexuses, are all congested; the centres of the lobules are red, while their non-congested margins are white, or yellow, or green, according to the quantity of bile in the ducts. This is the usual state of the liver after death, and arises from an impediment to the flow of blood through the hepatic veins, while the portal circulation still continues. This form of congestion will be very strongly marked in some diseases of the heart, and in acute disease of the lungs or pleuræ; in such cases the liver will be found large and full, from the quantity of blood it contains; sometimes also it will be in a state of biliary congestion; this combination gives rise to various appearances, known under the name of "nutmeg or dram-drinker's liver."

Portal venous congestion is very rare, and has been only seen in children. In this the congested portions are never so red as in the last form; the centres of the lobules are pale and non-congested, while the interlobular fissures and spaces are strongly so, and of a much deeper color than natural; from the liver this congestion may extend to the vessels of the alimentary canal, and give rise to gastric and intestinal hæmorrhages, also to hæmorrhoids and ascites.

In general congestion the whole substance of the liver presents a diffused red color, the central portions of the lobules being of a deeper hue than the margins.

Hypertrophy differs from congestion, and implies an actual increase in size and growth; it may be the result of chronic inflammation of the mucous tissue, or of any cause that has obstructed the circulation. In some instances it is found congested also, but in others pale and anemic.

Atrophy is denoted by diminished size of the whole or of a part; the lobules are indistinct, and often appear compressed by the cellular tissue, which is increased; the hepatic venous congestion is sometimes combined; the surface is often marked by irregular lines or grooves. This condition of the liver has been thought to have been induced, in some cases, by the injudicious pressure of tight dress; it may also be the result of antecedent chronic inflammation.

Cirrhosis is atrophy of the parenchyma and hypertrophy of the cellular tissue or basis of the liver; some lobules are wholly, others partially atrophied, and the remainder are in a state of biliary congestion; the organ is often diminished to one half its size, and changed into a shapeless mass, the surface withered, with furrows. ridges, and wrinkles, of varying tints of green and yellow. On dividing it, the structure feels dense, and is irregularly granulated; ascites, jaundice, and thoracic disease, are often concomitants to this abnormal condition of the liver.

The liver is sometimes *indurated* to an extraordinary degree with or without hypertrophy or atrophy; it is not unfrequently preternaturally *softened*, so as to break into a grumous pulp under very slight pressure; it is also sometimes so loaded with a fatty or oily matter as to resemble the liver of the cetacea; this state is termed *fatty degeneration.*

The liver is the deposit of various species of *tubercle;* the common scrofulous, the small diffused, the large circumscribed, the soft brown, the scirrhous, the fungoid, the melanotic, the hydatid; this latter is in the form of a cyst, which sometimes contains several smaller hydatids, one inclosing the other; these hydatids are classed by some under the head of the acephalyst entoza; small intestinal worms also have been occasionally found in the biliary ducts; these probably have ascended from the duodenum through the choledochus duct.

The morbid appearances found in the gall bladder are: great distension from obstructed ductus chôledochus, or total obliteration of its cavity from obstruction in the cystic duct; it often contains biliary calculi; if one only, it is usually large and ovoid; if many, as is commonly the case, they present every variety of form and size, with smooth sides and defined angles, the probable effects of constant friction one against the other.

The *spleen* is a soft, spongy, vascular mass, very variable in size and consistence; its texture, even in a healthy state, is often so weak and soft, or so brittle, as to break down under the slightest pressure. It has no excretory duct; but as its vein directly joins the porta, and so reaches the liver, it may with great probability be regarded as accessory to this organ in its function of sanguification or of depuration of the blood. It is situated in the left hypochondrium, between the stomach and the ribs, beneath the diaphragm, and above the kidney and the colon: it is in contact with and connected to the diaphragm by the peritoneum, also to the stomach and pancreas by vessels and by the peritoneum. It is somewhat of an oval form, or a longitudinal section of an ellipse; convex towards the ribs, and concave towards the stomach. On the latter surface there are several holes, and about the centre of it a depression or fissure, with a row of foramina for the entrance and exit of the bloodvessels and nerves; this depression is named *hilus of the spleen.* The gastro-splenic omentum, which contains the vasa brevia, is attached in this situation; all this surface is not equally concave; the part anterior to the vessels is most so, and is more or less closely related to the *cul de sac* of the stomach. The posterior portion is often convex, and is related to the left kidney, suprarenal capsule, left end of the pancreas, and left crus of the diaphragm, which separates it from the side of the spine. The smooth convex surface is in contact with the diaphragm, and by it is separated from the three or four last ribs. The upper extremity, large and round, is in contact with the diaphragm, and sometimes with the edge of the left lobe of the liver; the inferior and smaller, thin, and flattened, is in contact with the left part of the arch of the colon, rests on the meso-colon, and is movable; the posterior margin is thick and round, and often deeply notched; the anterior edge is more thin and sharp, and is also often deeply notched; these notches are uncertain, and appear rudimental divisions into lobes.

The spleen, though a fixed viscus, partakes of some motion or change of place according to the state of the surrounding parts, particularly of the diaphragm and stomach; in deep inspiration it descends a little, and when the stomach is distended, the lower extremity is turned somewhat forwards; it is then also more closely applied to the surface of its *cul de sac*, and has more of a horizontal than a vertical position. The size of the spleen is very variable, even more so than that of the liver; in some it appears shrunk, with its capsules wrinkled and loose, in others they are full and tense. It would appear, therefore, to be subject to distension and collapse, and many suppose

that these conditions alternate in the inverse ratio with the corresponding states of the stomach.

The color of the spleen is very variable, from a deep dark red to a pale gray, purple, livid, marbled, often like a leech; long exposure to the air brightens the red color.

The spleen possesses two coats, serous and fibrous; the serous or peritonæal invests all portions of it except the hilus, which corresponds to the space between the laminæ of the gastro-splenic omentum; it gives a smooth covering, and attaches it to the surrounding organs. The fibrous or proper coat is thin and transparent, but very elastic; the serous is closely united to it externally, and from its internal surface numerous shreds pass into the spleen all over its surface, while at the hilus it is not perforated, but inflected around the vessels, the ramifications of which it accompanies, and joins the processes derived from the surface, so as to constitute a cellular or areolar basis or framework to lodge and to support the vascular tissue of the organ; this areolar tissue may be well seen by macerating and washing away the blood from a divided spleen. Injection and inflation also demonstrate the same structure; this tissue is divided into compartments, and hence injection will sometimes fill some of these only, leaving the others flaccid. These fibrous cells are filled with a substance like grumous blood; they also contain a number of small red corpuscles, the nature of which is not understood. In addition to these cells and their contents this organ is essentially composed of bloodvessels. The splenic artery is the largest branch of the cœliac axis; it is remarkably tortuous, and enters the spleen by five or six branches; each of these pursues the same tortuous course within its substance, and divides into many ramifications; those from one branch do not join those from another, so that the spleen may be regarded as a number of spleens, as in the case of conglomerate glands: the spleen occasionally receives additional arteries from the phrenic, lumbar, and suprarenal. The splenic vein is much larger than the artery, and is the principal root of the vena porta; its branches form the greater portion or bulk of the organ, so that it resembles a venous erectile tissue; the cells are believed to communicate with the veins, or rather perhaps the former are but modifications of the latter, and that they are in fact composed of the lining membrane of the veins, supported by the fibrous sheaths and bands of the areolar texture.

The nerves of the spleen are very distinct; they are derived from the solar plexus, and twine around the artery and its divisions; some small filaments also from the pneumo-gastric, in the gastro-splenic omentum, pass towards it in the course of the vasa brevia.

The lymphatic vessels are superficial and deep; some pass from the stomach towards the hilus, and enter the lymphatic glands. The exact use or function of this viscus is not yet ascertained; sometimes two or more small bodies of the same color and structure as the spleen, are found in its vicinity between the laminæ of the omentum.

The spleen is not often found *diseased;* the greatest possible variety as to size and consistence is observed without any morbid change; in some cases it is so soft as to break under the slightest pressure: its coats are subject to thickening and induration, cartilaginous and even bony tubercles or patches are very common occurrences in its fibrous capsule.

The *pancreas* lies behind the stomach, and may be exposed by dividing the great omentum between this organ and the colon. This conglomerate gland, in color and texture, is very similar to the salivary glands; it is flat, thin, and elongated, about seven inches long, and an inch and a half broad; it extends from the lower part of the left hypochondriac and epigastric regions obliquely downwards and forwards into the umbilical region, where it is surrounded by the duodenum; it is covered by the stomach and the ascending layer of

the meso-colon; it lies anterior to the left crus of the diaphragm, the vena porta, the aorta, the vena cava, supérior mesenteric artery, left kidney and suprarenal capsule, and the two first lumbar vertebræ; the great end or head is encircled by the duodenum, the concave border of which it overlaps, and to which it adheres very closely, somewhat as the sublingual salivary gland does to the mucous membrane of the mouth: the middle portion is called the *body*. The splenic or left extremity (its *tail*) is small compared with the right, which is broad and flat, and is named the *head;* the anterior surface looks a little upwards, the inferior edge being raised forwards and separated from the duodenum by the superior mesenteric artery and vein, which pass behind it through a deep groove or tubular passage in the gland; a groove may also be remarked on its posterior and upper part, which contains the splenic artery and vein. The *pancreatic duct* is imbedded in its substance, and may be seen by scraping off some of the surface of the gland about its centre. This duct is remarkably white and thin; it commences in the small extremity of the gland, and extends to the large end, receiving in its course numerous branches on each side: it very generally joins the ductus choledochus in a small, ampulla-like dilatation, just before the duodenal opening; sometimes there is a second duct, which opens into the duodenum distinctly; attached to the head of the pancreas there is sometimes a glandular mass of the same structure as the pancreas, and opening by a small vessel into the pancreatic duct; this is named the *lesser pancreas.* The pancreatic fluid is supposed to be of use in diluting the bile, and rendering it and the contents of the duodenum more miscible with each other. The structure of the pancreas is similar to that of the salivary glands, and is thence called by some the abdominal salivary gland.

The pancreas is not often found in a *morbid* state; induration of its structure and calculi in its duct may be occasionally noticed, and in some cases distending the latter into a serous cyst: it is sometimes found adherent to the back part of the stomach, and in chronic ulceration of the coats of the latter this gland has been found supplying the deficiency, and thus preventing effusion from its cavity: its proximity to the aorta and to the pylorus renders it at times extremely difficult to distinguish between the diseases of each.

SECTION III.

OF THE VESSELS AND NERVES OF THE ABDOMEN.

The abdominal aorta gives off three large branches to supply the organs of digestion, viz., the cœliac axis, the superior mesenteric and inferior mesenteric arteries. The *cœliac axis* may be seen by tearing through the lesser omentum above the lesser curvature of the stomach; it arises from the forepart of the aorta, at the upper edge of the pancreas, is about half an inch long, and divides into three branches, the gastric, hepatic, and splenic; the *gastric* artery and its branches run between the laminæ of the lesser omentum, along the concave edge of the stomach, and supply both surfaces of this organ. The *hepatic artery* accompanies the vena porta and the biliary duct to the transverse fissure of the liver, first sending off a small branch to the pylorus (pylorica superior), next a large branch (gastro duodenalis), which descends behind the pylorus, and subdivides into two branches, the pancreatico-duodenalis and gastro-epiploica dextra; the former supplies the pancreas and duodenum; the latter runs along the convex edge of the stomach, between the layers of the great omentum; the hepatic artery then divides into the right and left hepatic arteries, which supply the right and left lobes of

the liver; the right hepatic is the larger, and gives off a small branch, arteria cystica, to the gall bladder. The *splenic artery* is the longest and largest branch of the cœliac axis; it passes along the upper and posterior part of the pancreas, to which it gives many branches; near the spleen it sends off the gastro-epiploica sinistra, which runs along the convex edge of the stomach, between the layers of the great omentum; the splenic artery then divides into five or six branches, which enter the foramina in the concave surface of the spleen: from these splenic branches five or six small arteries, the vasa brevia, pass to the left or great end of the stomach. The *superior mesenteric artery* arises about an inch or less below the cœliac axis, behind the pancreas; it descends in front of the duodenum, enters the mesentery, and bends obliquely towards the right iliac fossa; from its left or convex side it sends off sixteen or eighteen branches, which supply the jejunum and the ileum, and from its concave or right side arise three branches, the ileo-colica, colica dextra, and media; these arteries supply the corresponding portions of the colon, and inosculate with each other. The *inferior mesenteric artery* arises a little above the division of the aorta into the iliac vessels; it descends to the left side, and divides into three branches: the colica sinistra, which supplies the left lumbar colon, and inosculates with the colica media; the sigmoid artery, which supplies the sigmoid flexure of the colon; and the superior hæmorrhoidal, which is distributed to the rectum. These arteries are accompanied by corresponding veins, which all unite to form the vena porta. The *inferior mesenteric vein* accompanies the artery of that name to the aorta, and there joins the *superior mesenteric vein*, which is a very considerable vessel; this common trunk then ascends behind the pancreas, and is joined by a very large vein from the spleen; the confluence of the splenic and mesenteric veins forms the commencement of the *vena porta;* this vessel ascends obliquely to the right side, surrounded by nerves and cellular membrane, and inclosed in the lesser omentum; near the transverse fissure it becomes dilated (the sinus of the porta), and divides into the right and left branches; the former is the larger, the latter the longer of the two; each branches out through the liver, surrounded by the capsule of Glisson, and runs in a transverse direction: by the assistance of minute injections their terminating branches can be traced to the lobular venous plexus, in which they end.

The nerves which supply the digestive organs are the eighth pair, and the splanchnic branches, from the sympathetic: the *eighth pair* descend along the œsophagus, and are distributed almost wholly to the stomach; some few branches pass along the lesser omentum to the liver, some also join the solar plexus. The *splanchnic nerves* are two in number, a right and left; they are each formed by filaments from the dorsal ganglions of the sympathetic nerve in the thorax; they enter the abdomen either along with the aorta, or perforate the crura of the diaphragm on either side of that vessel; in the abdomen each nerve soon ends in a large ganglion, the *semilunar ganglion*, from which numerous branches pass across the aorta, around the cœliac axis, and communicating with each other, form the nervous plexus, named *solar* or *cœliac plexus*, from which a fasciculus of nerves extends along each of the branches of the cœliac artery to supply the viscera in the epigastric region; thus a few accompany the gastric artery, and communicate with the eighth pair on the stomach; several surround the hepatic artery, and by it are conducted to the liver; in like manner others also pass to the spleen. From the lower part of the solar plexus several large branches descend, and become attached to the superior and inferior mesenteric arteries, form plexuses around these vessels, and receive additional branches from the lumbar or abdominal ganglions of the sympathetic nerves; these nerves then twine around the mesenteric arteries and their branches, and are thus conducted to the intestines, in the internal tunic of which they terminate. *See* Anatomy of the Nervous System.

The student may now remove the abdominal viscera. Tie the lower extremity of the œsophagus and the upper end of the rectum, each with two ligatures, and divide these tubes between them; dissect out the vena cava from the liver, cut across the hepatic vessels, the cœliac axis, the superior and inferior mesenteric arteries; and then separate the liver, spleen, pancreas, and alimentary canal, from their connections to the parietes of the abdomen; next clean the surface of the abdominal aorta and vena cava, the right and left kidneys, and the renal capsules. The *obdominal aorta* may be now seen to pass into the abdomen, between the crura of the diaphragm, opposite the last dorsal vertebra; it then descends obliquely to the left side of the median line, and divides on the body of the fourth lumbar vertebra into the right and left iliac arteries. The abdominal aorta sends off the following branches: first, the two phrenic arteries; second, the cœliac axis; third, the superior mesenteric artery; fourth, the two renal arteries; fifth, the spermatic arteries; sixth, the inferior mesenteric artery; also four or five pair of lumbar arteries from its posterior part; and lastly, from the angle of its division the middle sacral artery descends. The *right* and *left iliac arteries* descend obliquely outwards and backwards; that of the right side is the longer of the two; opposite each ilio-sacral articulation each common iliac artery divides into the internal and external iliac. The *external* proceeds along the inner side of the psoas magnus, and, passing beneath Poupart's ligament, becomes the femoral artery; jnst above this ligament it sends off two branches, the epigastric and the circumflex ilii. The *internal iliac artery* descends into the pelvis, and gives off several branches, which shall be noticed afterwards in the dissection of that cavity. The veins in the abdomen correspond to the arteries; each *external iliac vein* ascends along the inner side of the artery of the same name, and near the sacrnm is joined by the *internal iliac vein*, which ascends from the pelvis; the union of these on each side form the *common iliac veins;* each of these ascends behind its accompanying artery; and opposite the right side of the fourth or fifth lumbar vertebra these veins unite, and form the inferior or ascending vena cava; the left common iliac vein is longer than the right, and passes behind the right iliac artery. The *vena cava* ascends along the right side of the aorta, and receives the spermatic, renal, and lumbar veins; it lies, inferiorly, on the right psoas muscle, and on the right crus of the diaphragm; superiorly, it inclines forwards and to the right side, and enters the fissure in the liver; here it receives the venæ cavæ hepaticæ; it then passes through the opening in the tendon of the diaphragm, and arrives at the right auricle of the heart. On each side of the abdominal aorta the *sympathetic nerves* may be seen; they pass from the thorax into the abdomen, beneath the true ligamentum arcuatum, and then descend between the crus of the diaphragm and the psoas magnus on each side; in this course they form three or four oval ganglions. At the last lumbar vertebra these nerves pass outwards and backwards, and then descend into the pelvis.

The commencement of the *vena azygos* may be observed on the right side of the aorta; it is formed by the first or second lumbar veins, which communicate with the renal and inferior lumbar veins, and sometimes with the inferior vena cava. The vena azygos enters the thorax between the aorta and the right crus of the diaphragm, and then ascends along the posterior mediastinum. The *thoracic duct* also may be seen to commence in the abdomen by the union of several absorbent vessels on the body of the third lumbar vertebra; this vessel, being larger here than it is above, has received the name of *receptaculum chyli;* this, however, does not always exist. The thoracic duct is covered at first by the aorta; it then ascends obliquely to its right side, and enters the thorax between it and the vena azygos.

Let the student next examine the urinary organs; these consist, first, of the two kidneys, which secrete the urine; second, of the two excretory ducts,

the ureters, which convey this fluid to, third, the urinary bladder, which retains it for a longer or shorter time; and fourth, the urethra, which discharges it externally, and which, in the male, is common to both the urinary and genital organs.

SECTION IV.

DISSECTION OF THE KIDNEY AND URETERS.

THE *kidneys* present the well-known form of the kidney-bean; the size is not so variable as that of some other glandular organs, yet one is often found larger than the other; in general both are larger in the infant, and in the female than in the male. The average dimensions are from four to four and a half inches in length, about two in breadth, and one in thickness. Sometimes there is only one kidney, which is then very large, of an irregular shape, and partly extended across the spine like the pancreas; sometimes the two kidneys are connected by a transverse glandular band, and resemble a horse-shoe, the concavity upwards, in the same manner as the lateral lobes of the thyroid body are connected by the transverse or middle lobe, the concavity of which is also upwards. The color is a dark, brown red; the texture is very firm to the touch.

Each kidney is situated in the posterior part of each lumbar region, behind the peritoneum, between the last rib and the crest of the ilium, and corresponds to the two last dorsal and two first lumbar vertebræ; the right kidney is often a little lower than the left, particularly in the female, also if the liver be larger than usual; they are imbedded in a quantity of adipose substance, and lie on the diaphragm, psoas, and quadratus lumborum muscles, the fascia of the transversalis abdominis intervening; the right kidney is also sometimes in contact with the iliacus internus muscle: the ascending colon and duodenum lie anterior to the right, and the descending colon to the left kidney; the right is in contact with the liver above, and with the cæcum below; and the left with the spleen above and the sigmoid flexure of the colon below. The anterior surface of each is convex and directed outwards; the posterior is flat, and directed inwards; in the young subject the surfaces are very uneven, the kidneys at that age being lobulated. The external border of each is smooth and convex, and directly outwards and backwards; the concave edge is of much less extent, looks forwards and inwards, and presents the notch, or hilus, or pelvis, which is more open or distinct anteriorly; it contains the arteries, veins, and excretory duct; the veins are usually, but by no means constantly, anterior; the arteries, five or six in number, are behind these; and the ureter is posterior and inferior to both; a plexus of nerves and lymphatics accompany these vessels. The superior end of each kidney is rounder, larger, and nearer to the spine than the inferior, which is directed outwards; it is also surmounted by the suprarenal body. The kidney is described by some as having three tunics: serous, cellulo-adipose, and fibrous; the latter, however, alone deserves this name; the peritoneum is but very partially connected to its anterior surface only, and to a variable extent; the cellular and adipose substance, in which each organ is imbedded, differs in quantity and quality; in the young the cellular tissue predominates, in the old the adipose; the proper coat is a strong, smooth, fibrous membrane, which adheres closely to its substance, preserves its form, and is continued into its interior, along the vessels, as far as the calyces of the kidney; it also sends in small shreds or processes from almost every point of the surface;

Fig. 48.*

these are friable, and break in tearing this membrane from the gland, which is easily effected, and in doing which it can be divided into two distinct laminæ. Remove one kidney from the subject, and divide it by a perpendicular incision from the convex to the concave edge; the gland will then be found to consist of two distinct substances, the external or vascular, the internal or membranous, or the tubular cones. The external, vascular, or *cortical substance*, forms the superficial lamina of the gland, is about two lines thick, and sends long prolongations inwards, between the tubular fasciculi; it is of a deep red color, like muscle, particularly along its internal margin; when the three vessels of the kidney are injected minutely with differently colored fluids, and sections made of the cortex, the latter will be found to be very vascular and very tubular, as well as granular or glandular in appearance; the minute arterial and venous ramifications are entangled with convoluted uriniferous tubes (tubes of Ferrein), and by the aid of the microscope an immense number of small granules can be detected in connection with these tubes; these are the corpora or acini of Malpighi. The intimate structure of these Malpighian corpuscles has been ably investigated by Mr. Bowman, (the account of his anatomical researches, as well as his physiological views respecting the probable function of these bodies, have been published in his excellent paper in the Phil. Trans., 1842;) they are very minute, about the $\frac{1}{700}$ of an inch in diameter; their number corresponds with that of the convoluted urinous tubes, within the extremity of one of which each of them is lodged: a Malpighian corpuscle is a tuft of capillary arteries, arranged in loops closely pressed together and inclosed in a slight dilatation of the urinary tube, which thus forms a capsule for it; a small artery, called vas inferens, pierces this capsule, and then divides into the branches, which are coiled up to form this little vascular ball, from the interior of which a minute vein proceeds (vas efferens), which is smaller than the artery, pierces the capsule close to it, and along with other similar veins, enters the venous plexus, which surrounds the convoluted urinous tubes, and from which the blood is ultimately conveyed from the kidney by branches converging and uniting to form the renal or emulgent vein. Thus there are in this gland two perfectly distinct systems of capillary vessels, and through both the blood passes in its course from the arteries into the veins: the first is an arterial capillary system, forming the Malpighian tufts inclosed within the dilated extremities of the uriniferous tubes; the second is the venous plexus, which surrounds these convoluted tubes; this latter plexus resembles the portal plexus in the liver, which is entirely venous, though it receives the blood from the hepatic artery, and is in that gland the true secreting agent: so this renal plexus, which receives the efferent vessels of the Malpighian tufts, is essentially venous. Mr. Bowman advances the ingenious and plausible theory that the Malpighian or arterial capillary tufts are the media by which water, and the more simple and soluble elements of the urine, are discharged from the blood; whereas by the venous capillary plexus, which is analogous to the portal, the proximate constituents of urine, such as urea, lithic acid, &c., are separated from the system.

* A section of the kidney, showing its internal structure. 1. The suprarenal capsule, attached to the upper extremity of the kidney. 2. 2. The fibrous tunic of the kidney. 3. The vascular or cortical substance. 4. 4. The tubular portion. 5. 5. The papillæ. 6. 6. The calyces. 7. 7. 7. The infundibula. 8. The pelvis of the kidney. 9. The ureter.

Internal to the cortex is the *tubular substance*, which consists of fine vessels of a pale color and dense structure; arranged in pyramids or striated conical fasciculi, about fifteen in number; the base of each is directed towards the circumference, the apex towards the hilus of the kidney; the base adheres to the cortex, which, by its prolongations inwards, envelopes each cone completely, except its apex or papilla; all these envelopes are continuous; the section of this gland, therefore, shows that it is lobulated; each lobe is a perfect kidney; these lobes are partially separate in the fœtus, but in many animals are still more so during their whole life; in some they are so separate as to resemble a bunch of grapes; in partial disease of this organ, also, this lobular structure is occasionally well marked. These tubes are like fine hairs; they are numerous towards the cortex, but diminish in number as they approach the apex or papilla; although their diameter must be extremely minute, yet pressure on the cortical substance causes the urine to exude distinctly from these cut tubes, not only when they have been divided in the section, but also through numerous puncta on each papilla; in tracing these ducts from the apex of each cone towards the base, or towards the cortex, their number appears to increase by dichotomous division, and on arriving at the cortex a total change takes place in their appearance; at first view they would seem to end, or to commence abruptly at that line, but close inspection proves that they are continued into the cortical tissue, but altered in appearance and in direction; they become ramose and tortuous, are inseparably entangled with the venous plexus and the arterial capillaries, and end either in cæca or in loops or arches; hence the tubular structure of the kidney may be considered as consisting of two portions, one is convoluted and distributed through the cortex, the other is arranged in converging striæ to form the cones or pyramids, and is only enveloped by the cortex; this latter portion, or the tubular cones, are probably only excretory in their office; while the former, or the convoluted tubes, being surrounded by the venous plexus, and inclosing the Malpighian tufts, must be the seat of the essential part of the secreting process: at the junction of the cortex with the pyramids a line of a deep or red purple hue is observable, marking, in an undulating course, the whole extent of the inner surface of the former; in this line some peculiar mode of division and inosculation occurs between the renal arteries of each lobule, which up to this point have been distinct.

The *papillæ* or the *mamillary* processes form the apices of the cones, and as two of the latter often converge into one point, the number of papillæ is less by four or six than that of the cones; each papilla is perforated by several small holes, through which the urine may be observed to flow when the tubular cones are compressed; some of them are blunt-pointed or cupped, with the orifices in their depressions; each papilla is covered by a fine mucous membrane, which is continued through the foramina into the tubuli; this membrane is also expanded round its base, and forms a little cup or calyx, which receives the fluid as it distils from the puncta; the papillæ possess no peculiar tissue, and are, therefore, essentially similar to the tubular cones which end in it, or which form it; in its mucous epithelium, probably, there is some difference.

The calyces are the membranous or fibro-mucous cups which, by one extremity, embrace the bases of the papillæ, and by the other join the adjacent calyces to commence the ureter; their number, six or eight, is less than that of the papillæ, as two of the latter often unite into one, and are received into the same calyx; they are dense and white, composed externally of the fibrous coat of the kidney, and internally of a fine mucous membrane, which is continued from the ureter along the pelvis of the kidney, lines all the calyces, and is reflected in the form of a very fine membrane over each papilla, and most probably is continued into the tubuli uriniferi. The calyces in each ex-

tremity, as also those in the centre, unite in three small tubes, which, being of a funnel shape, are called *infundibula;* these have but a short course, and soon terminate in the *pelvis* of the kidney, which is a membranous reservoir formed by the union of the calyces or the infundibula, of a flattened oval figure, placed behind the bloodvessels of the kidney, and terminating in the ureter, which it resembles in structure; adipose substance generally surrounds it, as well as the infundibula and the calyces. Each kidney receives a very large artery (the renal or emulgent), which arises at right angles from the aorta: this divides into six or eight branches, which enter the notch in the gland, subdivide into numerous fine vessels, which proceed between the tubular portions to the cortex; at the line of junction of these two, or along the convexity of each conical fasciculus, these branches form a network of inosculating arches, from which proceed numerous capillaries; some are for the nutrient functions, and others, according to Mr. Bowman's views, become the vasa inferentia for the Malpighian corpuscles, in which they divide and subdivide, and finally converge to the vasa efferentia, or the efferent veins, which are smaller than the arteries; these veins then proceed to join the capillary venous plexus surrounding the cortical or the convoluted uriniferous ducts. The arterial plexus in the corpora Malpighiana separate the aqueous and saline, and the venous plexus the proximate principles of the urine, into the convoluted ducts; thence the fluid passes into the conical tubuli uriniferi, which convey it to the papillæ, through the small pores of which it gradually flows into the calyces, and from these into the pelvis, and so into the ureter. From the renal venous plexus the blood is conveyed by veins which converge to form the renal or emulgent veins; these veins, one on each side, open distinctly into the cava; the left renal receives the spermatic veins, is longer than the right, and passes in front of the aorta, below the vena porta and behind the duodenum and the superior mesenteric vessels.

The nerves are derived from the solar plexus, lesser splanchnic, and lumbar ganglions of the sympathetic. The lymphatics join the lumbar glands.

The function of the kidneys is to separate or excrete certain effete azotized substances, especially urea, which cannot be retained in the body with safety to health, or even with long continuance of life; these substances have accumulated in the blood during its circulation, and, if not removed, soon give rise to general disturbance in the system; the nervous centres in particular become deranged in function, and suffer as if under the influence of narcotic poison.

The *ureter* is the excretory duct of the kidney, and extends from it to the urinary bladder; each ureter is about eighteen inches long, and about the size of a goose-quill; its coats are very pale, and always appear collapsed. These vessels take an oblique course downwards and inwards to the pelvis; each then inclines a little forwards, continuing still to run downwards and inwards to the inferior and posterior part of the bladder, passes obliquely between the muscular and mucous coats of this viscus, and perforates the latter at the posterior angle of the trigone. Each ureter passes anterior to the psoas magnus and to the iliac vessels, is covered by the peritoneum, and crossed obliquely by the spermatic vessels, and near its termination in the male subject by the vas deferens; and in the female by the Fallopian tube and broad ligament of the uterus. In the male each ureter attaches itself to the bladder at the posterior extremity of each vesicula seminalis, and now, much diminished in size, it runs obliquely for the extent of an inch between the tunics of the bladder, and opens internally (as will be seen hereafter in the dissection of the pelvic viscera) about an inch and a half from the commencement of the urethra, and about the same distance from its fellow. In the female the pelvic portion of each ureter is longer than the male; they

also lie at a greater distance from each other, and perforate the bladder nearer to its neck than in the male subject. The ureter is very dilatable; it is composed externally of a fibrous coat, and internally of a pale mucous membrane, without any valves or folds; it is surrounded by cellular tissue, and in some situations is partially covered by peritoneum; muscular fibres ascend from the bladder, and can be traced for some inches along its parietes. The ureters are larger at their commencement and smaller at their termination; the intermediate portion of each is nearly of one uniform diameter: two ureters on one or both sides are occasionally met with. The mucous membrane of the ureters and kidneys will be more particularly examined in connection with that of the bladder and urethra.

Attached to the upper extremity of each kidney is a small gland-like substance, named *renal capsule*, or the *suprarenal* or *atrabiliary body;* of a crescentic shape, the base attached to the kidney by cellular membrane and by small bloodvessels, the apex inclining inwards and forwards; these organs lie on the diaphragm, and on the semilunar ganglion of each side, opposite the tenth dorsal vertebra, and are covered, that on the right side by the vena cava and duodenum, and on the left by the spleen and pancreas; a vein also runs along their anterior surface; the right adheres to the under surface of the liver, the left is in contact with the spleen; these bodies are composed of an external thick lamina or cortex, which is of a yellow color and striated with perpendicular lines, and of an internal substance, soft or medullary, of a dark brown color, spongy, and traversed by vessels, often so soft and pulpy as to break down under examination. These organs receive several arteries; they are derived from the phrenic, the aorta, and the renal; the veins are larger, and open into the cava or the renal vein; the nerves are numerous, they are from the semilunar ganglion and from the solar and renal plexus. In the interior of each we often find the appearance of a small triangular cavity filled with a brownish fluid; the walls of this cavity are very rough, no excretory duct can be found leading from it; the presence of this cavity is by no means uniform, some deny its existence altogether, and attribute the appearance of it either to decomposition or laceration, or to the opening of the vein. The exact use of these bodies is not ascertained. The renal capsules in the adult are thin, and of a brownish yellow color, and very variable as to size; the right has been observed to be larger and of a different form from the left: in the fœtus they are very large and vascular, nearly equal to the kidney in size, and contain a quantity of reddish fluid. These bodies, though usually described as appendages to the kidneys, yet have no such intimate connection with them as to lead to the idea that there is any functional association between these organs; there is more reason to suppose that they are influential in sanguification during uterine life, and, like the liver, thymus, and thyroid bodies, all large at that age, are concerned in the economy of the fœtus, and probably assist in performing some offices connected with embryonic existence, nutrition, and growth.

The kidneys occasionally present the following *morbid* appearances: inflammation or nephritis is denoted by increased redness, of a dark tint, vascularity, and induration, and sometimes attended with purulent infiltration; when the ureter is engaged it is also found thicker and redder than natural, with purulent matter on its inner surface. Inflammation also sometimes ends in a well-defined abscess in the kidney. The inflammation may have involved all the tissue in the gland as well as its coverings; or it may be confined to the former without the latter being engaged, or it may be seated in the mucous lining of the calyces and pelvis of the ureter. In both acute and chronic inflammation of this organ red dots and ecchymosed spots are often observable both on the surface and in the cortical tissue; similar dots are also often seen in the early stage of Bright's disease, or granular degeneration with al-

buminous urine; these probably indicate inflammation of the Malpighian corpuscles, which, as they become enlarged and indurated, impair the other tissues, and the function of the gland is proportionably deranged. These glands are frequently the seat of scrofulous abscess, in which the pus is white and curdy. Calculi are very common in the kidney, sometimes they are small, and found in the tubular portion, but generally they are large, and fill up more or less of the pelvis of the ureter, not unfrequently extending by a stalk a short distance along that tube, and presenting a branched appearance at the opposite extremity corresponding to the infundibula. When the calculus is large and obstructs the flow of urine, the membranous portions of the gland become dilated, and should the stone be impacted lower down in the ureter, this tube will also become greatly dilated above the seat of the obstruction; in such cases the interior of the kidney will become more and more compressed and absorbed, and in time nothing will remain but the thickened capsule with a thin layer of vascular and glandular matter, containing several cells which communicate freely; sometimes the whole of the sac will be found in a state of suppuration. Hydatids are common formations in the kidney, they are found on its surface and beneath its capsule; they are generally scattered, each in its distinct cell. The kidneys present great variety as to form, size, color, and consistence, without any known corresponding difference in function. In diabetes they have been found large, vascular, soft, and easily torn; in purpura with hematuria the lining membrane has appeared turgid, and petechiæ have been distinctly seen beneath it. The kidneys may be the seat of cancer, fungus hæmatodes, and melanosis.

The bladder and urethra are the next divisions of the urinary organs to be examined; as these, however, are pelvic viscera, we shall postpone their consideration for the present, and the student should next examine the deep muscles of the abdomen, viz., the diaphragm, the quadratus lumborum, psoas parvus, psoas magnus, and iliacus internus of each side.

SECTION V.

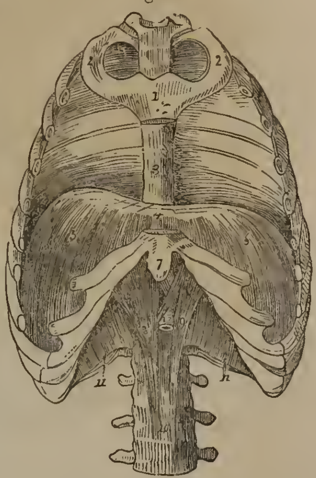
DISSECTION OF THE DEEP MUSCLES OF THE ABDOMEN.

[Diaphragm, *Vide page* 246.
Quadratus Lumborum, " " 253.
Psoas Parvus, " " 554.
Psoas Magnus, " " 254.
Iliacus Internus, " " 256.]

The Diaphragm is one of the most important muscles in the human body, second only to the heart; it is the principal agent in respiration, and belongs to the class of mixed muscles; volition can influence it to a great degree, but cannot wholly control its actions, which continue with surprising regularity through the whole of life, during sleeping and waking time, almost without our cognizance; its structure also partakes of the mixed character; in color, in the possession of tendon and of fixed osseous attachments, it is like the voluntary, while in thin tissue and expanded form, and in being single, it resembles the involuntary or the hollow muscles; and though it is attached to or encircled by bones, yet it is not designed to act on these as levers, like the voluntary muscles, which latter always lie around or external to the bones they are to move, whereas its contractions are only intended to influence the regions and the viscera between which it is interposed. This muscle should

be examined both on its abdominal and on its thoracic aspect; in the former it is exposed when the abdomen has been opened, its viscera removed, and the peritoneum with the connecting lamina of fine and closely adhering cellular tissue dissected from it; in the latter the thorax must be opened before the abdomen, and the heart and lungs, with the pericardium and pleuræ, detached: the inferior surface is generally selected for dissection and description. The diaphragm may be said to divide the body into an upper and a lower half, and to constitute an active and moving septum between the thorax and the abdomen, forming an irregular convex floor to the former, and a vaulted or concave ceiling to the latter; it crosses the median line, and, being but partially allied to the voluntary muscles, it wants the lateral symmetry of that system, although it is partially divided before and behind into right and left; the former, however, is more extended and more deeply arched than the latter. It is usually divided by the anatomist into two portions, but which are not to be considered as distinct muscles: one is superior, large, and broad transversely (the true or costal diaphragm); the other is inferior and posterior, small, thick, and narrow (the appendix, crura, or pillars, or vertebral diaphragm); these two portions, though separated at their osseous attachments, are yet blended together in the common central tendon, and present a fan-shaped expansion, bent at their junction, the broad superior expanded portion being nearly horizontal or with an aspect downwards and forwards, while the posterior inferior portion is vertical, and joined to the former at nearly a right angle, and has its surfaces directed forwards and backwards.

Fig. 49.*



The *superior* or true *diaphragm* is broad, thin, and circular, or rather transversely elliptical, being narrower from the sternum to the spine than from side to side, fleshy in the circumference, tendinous in the centre, *arises* anteriorly from the back part of the xiphoid cartilage by two weak fasciculi, separated by a line of cellular tissue (the median line, analogous to that which separates the crura posteriorly); these fibres are sometimes absent, and then a considerable deficiency exists in this situation: in some they are very strong, and appear to draw the cartilage inwards and backwards; external to these, and between them and the lateral fibres, there is in general a well-marked triangular space on either side, in which the pleuræ and peritoneum are connected by cellular tissue, and through which the terminating branches of the internal mammary vessels pass to the abdominal parietes; thoracic and cervical abscesses sometimes take this course, and point to the epigastric or umbilical region; violent exertion also might even force some of the abdominal viscera through this weak part so as to cause diaphragmatic hernia: the lateral and middle fibres arise from the internal surface of the cartilages of the

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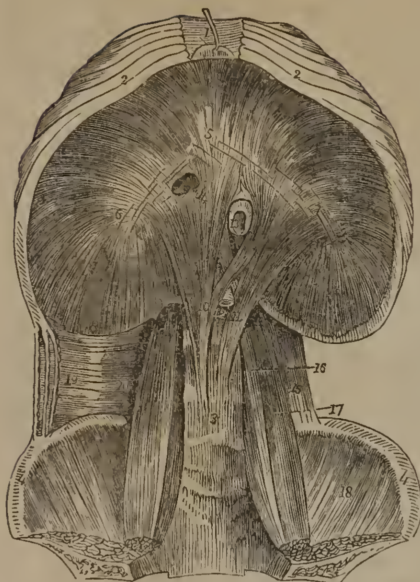
* A view of the diaphragm during expiration. 1. The superior extremity of the sternum. 2. The first rib. 3. The dorsal region of the spine. 4. The superior surface of the central tendon of the diaphragm. 5. The right lateral portion of the diaphragm. 6. The left lateral portion. 7. The xiphoid cartilage. 8. The right crus or pillar of the diaphragm. 9. The left crus. 10. The body of the third lumbar vertebra. 11. The posterior fibres of the diaphragm. 12. The aorta passing between and behind the pillars of the diaphragm.

Fig. 50.*



last true and of all the false ribs, and from their contiguous bony portions, these fasciculi, at their origin, indigitate with those of the transverse muscles of the abdomen; the anterior are the shortest; the middle, those between the eighth and eleventh ribs, are the longest; the fasciculi from the two last ribs are often attached to a considerable portion of these bones, and are also often connected to the transverse muscles by a common aponeurosis; the posterior fibres are thin and weak, but longer than the anterior; they arise between the last rib and the spine, from the upper part of the strong but thin tendinous expansion, which is the anterior layer of the transversalis tendon, and which covers the quadratus lumborum muscle, and adheres to the last rib; the upper part of this fascia is strong, and so tense, when the last rib is everted, as to resemble a ligamentous cord between it and the spine, and has received the name of *external* or *false ligamentum arcuatum*, to distinguish it from the *internal* or *true ligamentum urcuatum,* which lies internal to the former, and is a true tendinous arch, attached by one cornu to the transverse process of the first lumbar vertebra, and by the other to the body of the second and to the tendon of the adjacent pillar or crus of the diaphragm; this true ligament, concave downwards, arches across the sympathetic nerve and the upper end of the psoas magnus muscle; the anterior branch of the last dorsal nerve passes beneath, or rather through the external ligament; the posterior fibres of the true diaphragm arise from these two ligamentous structures; those from the true or internal ligament are stronger, and are in connection with the outer border of each crus; those from the external or false ligament are pale, weak and indistinct, and very often deficient in muscular structure; from this extensive circular origin the fibres converge towards the central tendon, like radii from the circumference to the centre of a circle; the anterior, short and slender, pass backwards and upwards to its border, the lateral or middle fibres inwards and upwards, and then a little downwards to its sides, forming curved lines or arches concave downwards, convex upwards; those on the right side

* The inferior or abdominal surface of the diaphragm. 1. The sternum. 2. 2. The costal cartilages. 3. The body of the third lumbar vertebra. 4. 4. The crests of the ilium. 5. 6. 7. The superior or true diaphragm: the figure 5 is placed on the anterior portion of the central tendon, the figure 6 upon the right, and the figure 7 upon the left division. 8. The posterior fibres of the diaphragm arising from the false or external ligamentum arcuatum. 9. The true ligamentum arcuatum. 10. The right crus of the diaphragm. 11. The left crus. 12. The aortic opening in the diaphragm through which the aorta is seen passing. 13. The inferior extremity of the œsophagus passing through the œsophageal opening. 14. The opening for the vena cava. 15. The quadratus lumborum muscle. 16. The psoas parvus. 17. The psoas magnus. 18. The iliacus internus: the inferior extremities of the last three muscles have been removed. 19. The posterior portion of the transversalis abdominis muscle giving origin to its posterior tendon, the anterior lamina of which (20) is seen passing in front of the quadratus lumborum muscle.

are longer and more arched than those on the left, the convexity of the former being on a level with the fourth rib, that of the latter with the fifth or sixth; these long, curved, lateral fibres are immediately beneath the lungs; the posterior fibres pass upwards and forwards to reach the back part of the tendon.

The *central* or *cordiform tendon* of the diaphragm (phrenic centre) occupies considerable extent, and being surrounded or insulated by fleshy fibres, it constitutes the diaphragm a digastric muscle both from before backwards, and from side to side. It is a thin, tendinous expansion, of great transverse breadth. Its figure has been compared, not unaptly, to the trefoil leaf, the posterior notch receiving the insertion of the crura as the stalk, one leaf or lobe extending towards the left side beneath the left pleura; this is the smallest division, is long and narrow: a second leading forward towards the xiphoid cartilage; this is usually the broadest and the strongest portion, lies on a plane inferior to the others, and is immediately beneath the heart and pericardium: the third, extending to the right side, is larger than the left, and very often equal to the anterior or middle division. The relative size of these lobes is variable, and the tendon altogether is smaller in proportion in the young than in the old; its fibres radiate from behind forwards and outwards, but are interlaced by transverse and oblique bands, in addition to which strong accessory fasciculi are attached to it, and cross it in different directions; some of these are unattached in their centre, these are chiefly seen on the right leaf. This platted texture is more distinct on the abdominal than on the thoracic surface; it obviously imparts mechanical strength to this thin expansion. Behind the left division is the fleshy opening for the passage of the œsophagus; and behind the right, or rather in the angle between it and the middle lobe, is the tendinous one for the vena cava; of these we shall speak presently. The tendon is the highest part of the diaphragm, less arched and more fixed than the fleshy portion.

Behind and below this tendon are the two *crura* or *appendices*, or *vertebral portions* of the *diaphragm*, nearly parallel to the spine. The *right* crus, longer, thicker, and on a plane anterior to the left, *arises* by tendinous fibres from the anterior and right lateral surface of the bodies of the first four lumbar vertebræ and their intervertebral ligaments; the *left*, smaller and on a posterior plane, *arises* from the left side of the two first vertebræ; both are confounded with the anterior vertebral ligament, and both also receive their external fibres from the true ligamentum arcuatum; they ascend obliquely forwards, diverging a little, but are soon connected to each other by a semilunar tendinous band, concave downwards, which is arched over the aorta and thoracic duct; this tense cord is opposite the last dorsal vertebra; it might be named the middle ligamentum arcuatum; from its convex edge fleshy fibres proceed to each crus. A little above this the crura not only approximate so closely as to appear as one, but each sends a fasciculus to join the other; these are named the *decussating fasciculi*: that from the right crus is the larger, that from the left is smaller, and sometimes it crosses the former on a plane anterior to it. The exact arrangement of these fibres is very variable, but they always separate the aortic from the œsophageal opening. The crura continue their course upwards and forwards, and, increasing in breadth, are inserted into the notch and into the posterior border of the central tendon. The right crus is immediately covered by the vena cava, the right suprarenal body, the semilunar ganglion, and the liver; the left by the aorta, left suprarenal body, and semilunar ganglion, spleen and stomach. The duodenum, pancreas, and vena cava are also anterior to both. The superior or true diaphragm is related inferiorly to the liver, stomach, spleen, and kidneys; it is lined throughout by the peritoneum, except at the coronary ligament of the liver, where the latter organ is in contact with it; also pos-

teriorly the kidneys intervene. It adheres to the muscular fibres by means of a fine but compact lamina of cellular tissue; much of the physical strength of the muscle depends on this connection; the fasciculi are often separated by considerable intervals, particularly near the ribs, and in the interstices the pleura and peritoneum are in juxtaposition. The thoracic surface is covered by three serous membranes, the pleura at each side, and the pericardium in the centre; this surface is flat in the middle, and convex on each side, particularly the right; the fibrous lamina of the pericardium adheres most intimately to the circumference of the anterior division of the tendon, particularly in front, where fibres of the latter ascend upon the former, and are lost in its tissue; these serve to fix the tendon, and prevent its depression or descent. The serous lamina is connected to the tendon more loosely within this fibrous attachment; the pericardium is also attached to the fleshy fibres between the anterior and left lobes; the adhesion between this membrane and the tendon is much less intimate in the child, and in some animals scarcely exists; in the mediastinal spaces, before and behind the pericardium, the pleuræ have no connection to the diaphragm; these membranes cover the superior lateral surfaces very perfectly, except small portions of their circumference, where the fleshy fibres come into contact with the triangulares sterni, intercostal, psoas magnus, and quadratus lumborum muscles; the diaphragmatic portions of the pleuræ and the connecting cellular tissue are not so dense as the corresponding structures on the lower surface, and do not impart such physical strength. Indeed the diaphragm is very variable as to texture or apparent strength; in some the fasciculi are very pale, weak, and separate; and in all cases, when both surfaces have been cleanly dissected, it possesses but little firmness or cohesion, loses its form, and becomes soft and flaccid; much, therefore, of its normal strength and tension depend upon its investments, particularly upon that of the lower surface.

Three large openings exist in the diaphragm: one for the aorta, of a semilunar form, and in the median line; one for the inferior cava, nearly square and to the right side; and one for the œsophagus, elliptical and to the left side.

The *aortic opening* leads from the posterior mediastinum into the abdomen, opposite the last dorsal vertebra, and nearly in the mesial line; it is rather a tendinous passage behind and between the crura, which fold inwards and meet in an aponeurotic expansion behind the artery, while, anterior to the vessel, is their connecting tendinous semilunar cord. The thoracic duct and vena azygos ascend through it along the right side of the aorta; the splanchnic nerves also, especially the left, sometimes escape by it; but these nerves, particularly the right, very often perforate the crus on each side, and thus divide one or both into secondary crura or pillars. This is almost always the case with the lesser splanchnic nerves; the parietes of this foramen are fixed, strong, and tense, and the fleshy fibres, which arise from its margin, cannot possibly contract its calibre, or constrict the parts passing through, as some have supposed.

The *opening* for the *œsophagus* and eighth pair of nerves, is superior, anterior, and to the left of the aortic, opposite the ninth or tenth dorsal vertebra, but not perfectly fixed, of an oval form, about an inch and a half long, and directed obliquely backwards and downwards; it is immediately behind the central tendon, which sometimes bounds its anterior extremity; the decussating fasciculi form its parietes, separate it from the aortic passage, and would appear capable of contracting it, and thereby closing the cardiac orifice of the stomach so as to prevent regurgitation of its contents when subjected to the pressure of the abdominal parietes.

The *opening* for the *vena cava* is at the back part of the right tendinous leaf, in the angle between it and the anterior, in front of the insertion of the right crus and opposite the ninth dorsal vertebra, on a higher plane than

either the aortic or œsophageal, to the right side of the median line, and nearly fixed in its position; its figure is an irregular square, the anterior or right sides being longer than the others; it appears larger than the vein, along which small filaments of the phrenic nerves also enter the abdomen; its margins are perfectly tendinous, with fasciculi crossing at right angles, and are attached to and prolonged upon the vessel, so as to form a sort of tendinous and valvular passage; the anterior and lateral descending to the liver, the posterior ascending to the pericardium and to the right auricle; the contraction of the diaphragm, so far from constricting this opening, must have an opposite effect, as the fleshy fibres, which are attached to three of its sides, will have a tendency to divaricate them, and so to enlarge the opening. The dimensions of the œsophageal and vena caval openings are so accurately adapted to the parts passing through them as to leave no opportunity for the escape of any of the viscera of the abdomen into the thorax; therefore, the diaphragm can be scarcely said to be deficient in these situations. The same remark applies to the five tendinous arches posteriorly, namely, the aortic in the middle, and the two ligamenta arcuata on each side; the first is fully occupied by the vessels passing through it, and its edges are connected by a dense tissue to the artery and to its great cæliac branch; the space beneath the true ligamentum arcuatum is filled by the sympathetic nerve and psoas magnus muscle, and a fascia is continued from its margins along the surface of the latter; there is no space or deficiency beneath the external ligamentum arcuatum; in addition to the three openings just described, there are numerous small ones for the passage of nerves and vessels, but too variable as to situation, and too insignificant in size, to merit particular attention.

The diaphragm is well supplied with blood; it is the seat of many inosculations between vessels from different and distant sources, whereby a due supply is secured, one proportioned to its importance in the economy, and adequate to maintain its irritability and power of long-continued action; the phrenic arteries behind, and other small branches from the aorta, from the renal and lumbars of both sides, the internal mammary in front, and the intercostals all around, are freely distributed to its tissue; the veins open into the cava either directly or into other veins proceeding to this trunk.

The nerves are numerous, and, in conformity with the mixed character of the muscle, are derived from the spinal and from the sympathetic systems. The spinal nerves are symmetrical; of these the two phrenic are the most important; they arise from the cervical segment of the spinal cord, or from the third and fourth cervical nerves, descend along the anterior scaleni into the thorax, and, passing on either side of the pericardium, arrive at the diaphragm; at the lower part of the neck they communicate with the sympathetic, pneumogastric and descendens colli nerves; near the diaphragm they divide into four or five branches, most of which pierce the muscle anterior to the tendon, but one or two accompany the vena cava on the right side; they ramify on the abdominal surface, the larger pass backwards, and many of them communicate with branches from the solar plexus; the intercostal branches of the five or six inferior dorsal nerves are distributed to its costal fasciculi, and branches from the superior lumbar to the crura; delicate filaments from the pneumogastric nerves are also sent to it from the cardiac portion of the stomach, and each phrenic artery is accompanied by a fasciculus from the solar plexus; these latter follow the divisions of these vessels into the most minute ramifications. Pathological research, and experiments on living animals, have established the fact that the phrenic nerves are the most influential agents in the respiratory actions of this muscle; the inosculations between these and the eighth, ninth, and sympathetic, establish important sympathies between this muscle and the tongue, larynx, lungs, heart, and stomach: the dorsal and lumbar branches probably associate it with the mus-

cles of the trunk, as we find it co-operating with these in all the violent exertions of the body, while the branches of the solar plexus, which accompany its chief nutrient arteries, may be regarded as essential to its organization, as well as establishing a sympathetic connection with the abdominal viscera. No other muscle in the body, then, receives nervous endowments from so many and from such varied sources,—a fact fully in accordance not only with its use and power, but also with the extensive sympathy it maintains with all the organic and animal functions of the system.

Use. It is the principal muscle in effecting inspiration, as it enlarges the chest in the perpendicular direction, and almost exclusively on each side; the crura act as long muscles do towards their origin, and slightly depress and draw backwards the central tendon; they also fix it. The superior diaphragm acts more like the hollow muscles; the border of the tendon, and the margins of the ribs, which are held steadily everted by the intercostal muscles, serve as its fixed points, and when the fibres contract they descend, and then, instead of being curved and convex upwards, become nearly straight, so as to present a plane surface to the abdomen, looking downwards and forwards; as the fleshy fibres are longest at the sides, it is here the greatest descent in the muscle occurs; consequently the thorax is most enlarged beneath each lung, and in proportion as this change takes place the air rushes into these organs by the larynx and trachea, to fill the enlarging thorax, and ordinary inspiration is said to have taken place. There is but little enlargement or alteration in the centre beneath the heart and great vessels; any such change in that situation would be not only useless, but injurious. When the diaphragm relaxes, its own elasticity, together with that of the pleuræ and pericardium, which are connected to its superior surface, aided by the pressure of the abdominal parietes against the viscera they inclose, cause it to reascend, so as again to present a concave surface to the abdomen, and to diminish the capacity of the thorax. The lungs are compressed in the same proportion; the air is expelled, and then expiration is said to have occurred. Although the diaphragm is commonly said to descend in inspiration, yet this assertion must be taken with some limitation; the tendinous centre admits of very little change in this direction, and the fleshy fibres can only become straight; accordingly the liver, stomach, and spleen are not much depressed, but these, as well as the other abdominal viscera, are pushed forwards rather than downwards; this may be ascertained by inspecting the abdomen during life in any person lying in the horizontal position on the back, prominence of the abdomen being synchronous with inspiration; but the most careful examination can hardly discover any descent of the margin of the liver in ordinary breathing; if, however, a very full inspiration be made, the viscera are then perceptibly depressed, and even a fulness in the perinæum is perceived; the attachment of the diaphragm to the ribs would, no doubt, tend to draw these bones inwards, and thereby contract the thorax transversely, which would be contrary to the general intention, but synchronous with its action is that of the intercostal and levatores costarum muscles, which, by fixing these bones, not only prevent such a result, but also actually enlarge the thorax by slightly elevating and everting their lower margins. In ordinary inspiration these are the only agents employed, the diaphragm and intercostal muscles; but in forced or in laborious breathing, several other muscles of the trunk and of the upper extremities assist, such as the sterno-mastoid, scaleni, subclavian, serratus magnus, trapezius, pectorals, latissimi dorsi, and serrati postici. Expiration does not require the same muscular exertion; its ordinary degree is chiefly effected by the elasticity and by the gentle resilient contraction of the abdominal parietes; the ribs and their cartilages, the lungs, the diaphragm, and the textures connected to its upper surface, all possess this property, and tend to produce this condition without any distinct muscular action, thus pre-

senting an example of an elastic or mechanical force saving an expenditure of a vital power; in violent expiration the abdominal muscles and levatores ani act with increased force, the triangulares sterni depress the cartilages of the ribs, the quadrati lumborum muscles assist in depressing these bones, the serrati postici inferiores may co-operate, so may the latissimi dorsi, by acting towards the lumbar vertebræ, and the arms themselves may be made to contribute by compressing the walls of the thorax; and should the last rib be fixed, it is also possible that the series of intercostals may become muscles for expiration; besides these ordinary respiratory movements, the diaphragm is also essentially concerned in other phenomena more or less connected with this function, such as snuffing, sighing, yawning, hiccough, &c. Neither is its influence on the abdominal viscera to be overlooked, its alternate depression and elevation must contribute to their functions; the secretions of the liver and pancreas, the contents of the gall bladder, stomach, and intestines, and the general circulation of the blood throughout this cavity, cannot fail to be beneficially affected by the constant motion and pressure of this muscle; in vomiting also it is concerned, a full inspiration preceding the expulsive efforts of the abdominal muscles and of the stomach itself; this is instantly followed by its relaxation, which opens the cardiac orifice: in the forcible expulsion of the urine and fæces it is retained in a state of strong contraction, and presents a resisting surface against which the abdominal muscles press the viscera, and thus expel their contents. In these abdominal actions it principally co-operates with the transversales, the only muscles with which it indigitates: a striking resemblance in structure exists between these and the diaphragm; the two transverse with their weak and loosely attached fasciculi and their central tendon, being a sort of digastric muscle expanded around the peritoneum, and forming, with the diaphragm, one continuous muscular sac, enveloping and compressing the digestive apparatus. We may regard this muscular envelope as completed below by the levatores ani, which, though described as two, yet might be considered a single muscle like the diaphragm, with its median aperture, opposed to it in situation, and in function, as far as respiration is concerned, but allied to it, and co-operating with it, and with the transversi, as general compressors and supporters of the abdominal viscera. The diaphragm also affords powerful assistance in many of the violent muscular exertions of the body, such as straining, wrestling, raising weights, &c.; by maintaining the thorax in an expanded state, it steadies the ribs, strengthens the trunk, and affords a firm support for the muscles that are engaged. We have already alluded to the possibility of diaphragmatic hernia occurring as the result of violent muscular efforts, either enlarging some of the natural openings, or bursting through some naturally weak or defective spot, or rupturing the muscle itself. Congenital deficiencies have been not unfrequently met with, but such are seldom compatible with continued existence, though some rare exceptions are recorded; such defects are to be considered as arrests of development, as the muscle in the very early periods of fœtal life is deficient, and grows only by degrees from the circumference towards the centre. Mammalia alone possess a perfect muscular diaphragm; in birds it is rudimental, the pillars and central tendon being absent, and the costal fasciculi inserted into the base of each lung; it is wanting in reptiles, fishes, and invertebrate animals.

Quadratus lumborum is thick, flat, round on its outer edge, irregularly square, the greater diameter being from above downwards, and the outer and lower borders longer than the upper and inner, situated in the lumbar region next the spine, between the ilium and last rib, forming part of the posterior wall of the abdomen, and, like the rectus muscle in front, inclosed in a strong aponeurotic sheath, formed by the anterior and middle laminæ of the tendon of the transversalis muscle, behind the colon and the kidney, the psoas and

the diaphragm, and in front of the extensor muscles of the spine, and anterior to the sacro-lumbalis; *arises* tendinous from the posterior fourth of the crest of the ilium, and from the ilio-lumbar ligament; the fibres ascend obliquely inwards, and are *inserted* into the extremity of the transverse processes of the four first lumbar vertebræ and of the last dorsal; also into the internal surface of the posterior half of the last rib, beneath the external or false ligamentum arcuatum; the external or ilio-costal fibres are more vertical, the internal or ilio-lumbar more oblique; these latter are usually crossed in front by another lamina of fibres, which ascend obliquely outwards from the three last transverse processes to the edge of the last rib. *Use*, to bend the spine to one side, to depress the last rib, and thus assist in expiration, being directly opposed to the scaleni; when both muscles act they support the spinal column in the perpendicular direction. The complex structure of this muscle gives additional strength and more varied power of action, and is analogous to the decussating laminæ of the other abdominal muscles, or to the double layer of the intercostals, of which it may be regarded as a modified continuation.

Psoas parvus, long, flat, thin, and narrow, fleshy in its upper third, tendinous below; situated in front of the psoas magnus, and on its outer aspect above, its inner below; arises by short, fleshy, and aponeurotic fibres from the lower edge of the side of the body of the last dorsal vertebra, and sometimes from its transverse process, also from the body of the first lumbar, and the intervertebral substance; the fibres descend in a direction outwards, and opposite the fourth vertebra, end in a thin, glistening tendon, which crosses the psoas magnus, descends on its inner side, and is *inserted* broad and thin into the ileo-pectinæal eminence and adjacent part of the brim of the pelvis; it is also attached externally to the iliac fascia by a broad aponeurotic expansion, which binds down the psoas and internal iliac muscles; inferiorly it is connected to the inner and back part of the crural arch, and to the pubic portion of the fascia lata behind the femoral vessels, and in front of the common tendon of the psoas and iliacus. *Use*, it assists in bending the body forwards, or in raising the pelvis; it makes tense the crural arch, and diminishes the aperture beneath it. This muscle is often wanting; when present, it is connected to the psoas magnus by cellular tissue, and is partly concealed above by the diaphragm, the renal vessels, and the peritoneum, and below by the external iliac vein and artery.

Psoas magnus, long, round, thick in the centre, small in the extremities, fleshy above, tendinous below, extends along the sides of the lumbar vertebræ, the brim of the pelvis, and the anterior and inner part of the thigh. It *arises* by two planes of fleshy and aponeurotic fasciculi; one large, anterior, and internal; the other small, posterior, and external: the first arises from the side of the bodies of the two last dorsal and four first lumbar vertebræ, and from their intervertebral ligaments; the fibres are attached to the upper and lower margins only of the vertebræ, and in the intervals to a series of tendinous arches, which are extended over the lateral grooves on these bones, to protect the lumbar vessels and the nerves which communicate between the sympathetic and the lumbar: the posterior fasciculi arise from the bases of the transverse processes. In the space between these two planes the lumbar plexus of the spinal nerves is contained, as the brachial plexus separates the scaleni muscles. The fibres all descend, at first vertically, afterwards obliquely outwards, along the brim of the pelvis, and, beneath Poupart's ligament, end in a tendon, which has been previously concealed among the fleshy fasciculi; this receives the fibres of the iliacus muscle externally, and is, therefore, the common or conjoined tendon of these two muscles. This tendon descends obliquely outwards to about the centre of the crural arch, and escapes into the thigh beneath Poupart's ligament, in the groove between

the inferior spine of the ilium and the ilio-pubal eminence; it then descends very obliquely inwards and backwards, being somewhat twisted round the hip joint, so that its anterior surface becomes turned inwards, and its outer edge forwards, and is *inserted* into and around the lesser trochanter of the femur; some fleshy fibres of the iliacus are also inserted into a ridge extending below to the linea aspera; as the tendon glides round this process a small bursa is usually interposed, and a very large one always exists between it and the pubis and the forepart of the capsule of the hip joint, and is sometimes found to communicate with the synovial membrane of the latter. *Use*, to flex the thigh on the pelvis, or the body on the thigh; it also rotates the thigh outwards; in standing it supports the spine, and prevents it bending backwards; it can then, also, especially by its iliac portion, rotate the body so as to turn its front to the opposite side; in walking it is particularly engaged, raises and throws forward the lower extremity, assisted by the rectus femoris, at the same time turning the knee and foot outwards: its power is greatly increased by the reflection of the tendon over the pully-like surface of the ilium, whereby its direction becomes more perpendicular to its insertion. This muscle is situated between the psoas parvus and the quadratus lumborum above, and between the former muscle and the iliacus below; and in the groin, between the sartorius and the pectinæus. Its insertion is between the vastus internus and the pectinæus, and as it extends round to the back part of the lesser trochanter, will be found to correspond to the horizontal line of separation between the quadratus femoris and the adductor magnus; the lesser trochanter projects a little in this line or cellular interval, and, if the body be placed on the forepart, this insertion may be exposed posteriorly without injuring any muscle, by dividing the skin just below the fold of the natis and on the outer side of the hamstring muscles, between the tuber ischii and the great trochanter. The psoas is covered in the lumbar region by the diaphragm, the ligamentum arcuatum, the psoas parvus, the sympathetic nerves, the kidney and its vessels; also on the right side by the vena cava and ascending colon, and on the left by the aorta and descending colon. In the middle or pelvic division it lies between the external iliac vessels internally, and the iliac muscle and anterior crural nerve externally; is covered by the peritoneum, on the right side also by the ileum, cæcum, and vermiform appendix, and on the left by the sigmoid flexure of the colon. The two psoæ, together with the external iliac vessels, in this situation, overhang the margins of the pelvis, so as to diminish the transverse diameter of the upper orifice by at least half an inch; the psoas is here also covered by the iliac fascia and the expansion of the psoas parvus; the external iliac artery and vein are to its inner or pelvic side above, but, inferiorly, the artery is in front of it; these vessels are connected to the muscle and its investing aponeurosis by the fascia propria; the anterior crural nerve is external to it, but on a deeper plane, being imbedded in the groove between it and the iliacus, and behind the iliac fascia; in its lower or inguinal division it is partly covered by the femoral artery and vein, and by some of their branches, also by the inguinal glands, and by a considerable quantity of cellular membrane, which separates it from the fascia lata. The internal circumflex vessels follow the course of the tendon to the back part of the thigh, and separate it from the pectinæus muscle. The psoas lies anterior to the transverse processes of the lumbar vertebræ, to the quadratus lumborum, the lumbar nerves, the inner edge of the iliacus internus, the ilio-pubal symphisis, the acetabulum, and the capsular ligament of the hip. The structure of this muscle is peculiar, not only in man, but in animals, as is well seen in those fattened for the table; the fasciculi are very long and very tender, the connecting cellular membrane being very soft and delicate, and devoid of all fibrous and elastic tissue; the investing sheath also is thin and fine. In chronic inflammation of

this muscle, ending in suppuration, this sheath becomes very thick, and confines the pus as in a sac; it is lined by organized lymph, and some pale, attenuated muscular fibres are expanded on it: the form of the muscle is preserved, but enlarged; this disease is termed "psoas abscess," and is in general connected with disease of the lumbar vertebræ, or intervertebral ligaments.

ILIACUS INTERNUS, flat, or rather concave, radiated or triangular, *arises* fleshy from the transverse process of the last lumbar vertebra, ilio-lumbar ligament, base of the sacrum, the inner margin of three anterior fourths of the crest of the ilium, the two anterior spinous processes of this bone, and the intervening notch, from the brim of the acetabulum and the capsular ligament, also from the iliac fossa, and from the strong aponeurosis, the iliac fascia, which covers it. This fascia is attached to the crest of the ilium and to Poupart's ligament as far inwards as the iliac artery, behind which it passes and becomes continuous with the pubic portion of the fascia lata; the fibres of this muscle all descend obliquely inwards, join the outer side of the tendon of the psoas magnus, and are *inserted* along with it, or rather into it; the inferior fleshy fibres, which are attached to the inferior iliac spine and to the capsule of the hip joint, are also inserted into the anterior and inner surface of the femur, below the lesser trochanter; these fibres often appear as a separate muscle, which has been named ilio-capsular. *Use*, to assist the psoas in flexing the thigh, and in rotating it outwards; also in abduction, it protects the forepart of the capsular ligament, and in flexion of the thigh draws it out of the angle between the neck of the femur and the edge of the acetabulum: it fills up the concavity of the iliac fossa, some inguinocutaneous nerves descend upon it; on the right side it is covered by the cæcum, on the left by the colon; in the groin it is partly covered by the sartorius, and lies upon the rectus and on the capsular ligament, anterior to the glutæus medius, and internal and posterior to the tensor vaginæ femoris. We may next proceed to the dissection of the perinæum and the viscera of the pelvis.

SECTION VI.

DISSECTION OF THE PERINÆUM IN THE MALE.

[THE muscles to be examined in this region are fourteen in number, so arranged as to form two single muscles, and six pairs, as follows.

Single.

1. Sphincter Ani,	*Vide p.* 258.
2. Sphincter Internus or Orbicularis,	

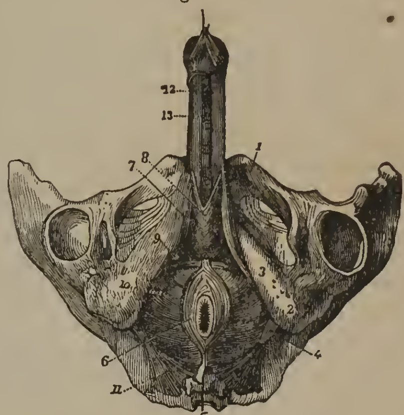
Pairing.

3. Erectores or Compressores Penis,	*Vide p.* 260.
4. Acceleratores Urinæ or Ejaculatores Seminis,	
5. Transversales Perinæi	" " 261.
6. Levatores Ani,	" " 264.
7. Compressores Urethræ,	" " 265.
8. Coccygei,	" " 267.]

Place the subject on the back, bend the thighs and knees upon the trunk, and secure them in the same position as in the lateral operation of lithotomy; the dissection will be facilitated if the pelvis be raised by a block placed beneath it; moderately distend the lower end of the rectum with sponge or

curled hair; introduce a staff or catheter into the urethra and bladder; secure the penis to it by a ligature, and raise up the scrotum. The *perinæum* extends from the os coccygis behind to the arch of the pubis before; is bounded on each side by the rami of the pubis and ischium, by the tuber ischii, and by the great sacro-sciatic ligament, which extends from that process to the side of the sacrum and coccyx; the glutæus maximus overhangs this ligament; the tuberosity and ramus of the ischium can be felt through the integuments, also (unless the subject be very fat) the ramus of the pubis leading obliquely upwards on each side to the symphisis. The form and extent of the perinæum are much influenced by the position of the body and lower extremities; when the latter are approximated, it is but a narrow space or groove containing the anal opening and the root of the scrotum and penis; but when the thighs are divaricated and flexed on the pelvis, it presents a considerable area, the average diameters of which measure, transversely, that is from one tuber ischii to the other, three inches or three and a half, and from pubis to coccyx four inches or four and a half.

Fig. 51.*



The integuments of the perinæum and scrotum are generally of a dark brownish color in the adult, and of a reddish hue in the child; very thin around the anus, and covering the scrotum, but dense in the intermediate space: along the mesial line a prominent hard ridge is observable, the *raphe* of the perinæum; this line commences in front of the anus, and extends along the perinæum, scrotum, and penis, as far as the prepuce of the latter. Beneath the raphe the prominence of the urethra can be felt, commencing a little in front of the anus.

The *anus*, the inferior opening of the alimentary canal, is deeply placed in the groove between the nates, midway between the tuberosities of the ischia, about an inch or an inch and a half in front of the coccyx, and three inches from the arch of the pubes; the integument is inflected through it to be continuous with the mucous membrane of the intestine; the skin around is thin, studded with cebaceous follicles, and in the adult male with a few hairs; it is puckered into radiated plaits, extending inwards and very distinct when the opening is contracted, but effaced when distended; the cuticle can be traced inwards about a quarter of an inch, and ends in a regularly waved or festooned border, concave upwards. Cautiously cut through the skin all round this opening, and dissect off the integuments from all the perinæal region, we thus expose, posteriorly, a cutaneous muscle (the sphincter ani) surrounding the anus, and anteriorly a strong fascia covering the muscles of the perinæum, the crura penis, and the corpus spongiosum urethræ. In the examination of this region it is convenient, as well as practically useful, to consider it as divisible, not only into right and left by the median raphe, but

* The muscles of the perinæum. 1. The os pubis. 2. The tuber ischii. 3. The ascending ramus of the ischium. 4. The spine of the ischium. 5. The coccyx. 6. The sphincter ani. 7. The erector penis. 8. The accelerator urinæ. 9. The transversalis perinæi. 10. The inferior surface of the levator ani. 11. The coccygæus muscle. 12. The corpus cavernosum penis. 13. The corpus spongiosum urethræ.

also into an anterior and posterior part by an imaginary line extended from the forepart of one tuber ischii to the other; this line crosses the anterior border of the anus, and forms the base of two triangular spaces, the anterior (the urethal perinæum) has its apex at the arch of the pubis; the posterior (the anal perinæum) has its apex at the point of the coccyx.

Sphincter Ani, cutaneous or externus, is flat, thin, oval, pale, and open in the middle; it *arises* from a fibro-cellular substance, which extends from the os coccygis to the rectum (recto-coccygeal ligament); the fibres descend obliquely forwards, expanding on either side nearly as far outwards as the tuberosity of the ischium; at the posterior part of the anus the muscle divides into two fasciculi, which pass, one at each side of this opening, and unite at its anterior part, thus encircling this orifice; *inserted* into the raphe in the integuments, and into the superficial fascia; a fasciculus of it also perforates the latter, and is inserted into the common central point of the perinæum; a point which will be more fully seen when the fascia shall have been raised. *Use*, to close and raise the anus: it may also draw the bulb of the urethra backwards and downwards, and compress it; this muscle is almost constantly in a state of contraction, and, like all the sphincters, belongs to the class of mixed muscles; one surface looks downwards, and is superficial; the other looks upwards, and is connected to the levatores ani muscles; one edge is internal, the other external: its lateral extent is much greater in some subjects than in others; a few of its external fibres must be divided in the first incision in the lateral operation of lithotomy; in the male the anterior fasciculus is often very long, but its mode of insertion variable; in the female the sphincter is shorter, broader, and more rounded in front. Beneath and internal to this muscle, we may expose the following with very little dissection.

Sphincter Internus *vel* Orbicularis, consists of a thick, but pale fasciculus of muscular fibres, encircling the lower extremity of the rectum, having no attachment to the coccyx behind, and but a slight one to the central point before, but is in close contact with the mucous membrane of the intestine; its surfaces are internal and external, its edges superior and inferior. *Use*, to assist the former in closing the extremity of the rectum; also in defæcation it assists in the expulsion of the residual portions of the fœcal matter by the sudden or almost spasmodic action which succeeds its relaxation; it also strongly opposes the entrance of any foreign body by the anus, and may be considered as analogous to the pylorus; its upper edge is continuous with the circular fibres of the rectum, its lower edge is only separated by a cellular line from the cutaneous sphincter. The subcutaneous or submucous tissue of the anus has some of the characters of erectile tissue, it contains a network of minute arterial inosculations, and a plexus of numerous tortuous veins; these are very liable to become varicose, and to lead to the formation of hæmorrhoids and hemorrhoidal tumors, of which there is a great variety; in some cases there is merely a dilated vein or veins, in others there are prominent, firm tumors, of a livid or purple hue, very thinly covered and liable to abrasion and hæmorrhage; these are often connected with the veins; in some there are vascular, cutaneous folds, and in others fleshy-looking growths from the mucous membrane, which occasionally protrude through the anus, particularly during dafæcation, and bleed so freely as to cause some alarm for the safety of the patient; these veins join the hæmorrhoidal or inferior mesenteric vein, which is one of the roots of the vena porta.*

Anterior to, and on each side of the anus, we find beneath the integuments a condensed cellular texture, covering the other muscles in the perinæum: this is the *superficial fascia;* it is continued from the inner side of one thigh across the perinæum to the opposite, adhering to the fibrous tissue which

* See art. "Anus," in Todd's Cyclop. of Anat. and Phys.

covers the rami of the ischium and pubis on each side; this fascia is very dense about the middle of the perinæum; posteriorly on either side of the anus, it is loaded with soft, large-grained, adipose substance, and is continuous with the cellular tissue in the ischio-rectal spaces behind the transversi perinæi muscles; anteriorly, it extends over the scrotum, becomes thin and fine, like reticular membrane, and is continuous with the superficial fascia from the abdomen; it is covered by the superficial sphincter, and by the dartos, which is prolonged upon it in the median line further than on either side; it covers and partly envelopes the superficial perinæal vessels and nerves, also all the muscles in the anterior perinæal region. Separate this fascia from one side of the perinæum, and reflect it towards the opposite, its density and close connection to the lateral boundaries of this region will then become obvious; a number of veins and nerves, and a quantity of fat also, will be observed; when the latter is dissected away, those muscles of the perinæum, which are attached to the penis and urethra, will appear, covered, however, by a fine but dense and semi-transparent aponeurosis; this may be called the *deep fascia* of the perinæum, although this term is usually applied to that aponeurosis which is placed still deeper in this region, and which is also called the triangular ligament of the urethra, or the interosseous membrane, or the septum perinæi, as it separates the anterior perinæum from the pelvis. The aponeurosis we are now alluding to might, perhaps, to avoid confusion, be named the *middle fascia* of the perinæum; though thin, it is strong, and essentially aponeurotic: it forms a close investment for the erector penis and accelerator urinæ muscles, and is folded round these, except their upper or attached surface; over the transversus perinæi it is very thin, and scarcely exists:* this fascia must be carefully raised, and the muscles will be exposed; these are six in number, three on each side, viz., the erector penis, transversalis perinæi, and accelerator urinæ. If the perinæum be divided by the transverse line, drawn, as was before indicated, from one tuberosity of the ischium to the other, into an anterior and posterior part, we shall find that the anterior triangular space, or the *urethral* region, contains in the male subject the six muscles just named, also the crura penis and the corpus spongiosum urethræ, with their bloodvessels and nerves; the posterior-triangular division, or the *anal region*, contains the lower extremity of the rectum, surrounded by the cutaneous and deep sphincters, also on each side of this intestine a considerable quantity of fat, filling up the space between the side of the rectum and the obturator internus muscle and fascia; this is the *ischio-rectal space*, a deep conical recess, the base towards the skin, the apex towards the pelvis, bounded externally by the ischium, which is lined by the obturator fascia; internally by the side of the rectum, covered by the levator ani and by the anal or ischio-rectal fascia, narrow above, and closed by the last-named muscle and fascia, which form an oblique septum between the pelvis and this space; anteriorly by the transversus perinæi muscle, and posteriorly by the coccygæus; each of these recesses is lined on all sides, except inferiorly or towards the skin, by fascia, a view of which is obtained by dissecting out the contained adeps; there may then be observed near the apex, or the deepest part, a strong, tense, aponeurotic line; this is the inferior, folded, or convex surface of the pelvic-fascia, which here sends off its inferior layer, and which immediately divides into two laminæ, an external and internal; the latter is named *anal* or *ischio-rectal fascia*, is thin and weak, descends upon the lower or outer surface of the levator ani to the sphincter, where it is lost in the surrounding cellular tissue; the former or external lamina is the *obturator fascia:*

* Both this and the superficial fascia resist collections of urine or of pus from coming to the surface; they also cause the tendency to infiltration of the urine forward into the scrotum and upwards on the abdomen, in cases of rupture of the urethra.

it is dense, strong, and glistening, descends obliquely outwards, and is inserted into the falciform process of the great sacro-sciatic ligament, and into the tuber and ramus of the ischium; it covers the obturator internus muscle, and incloses the pubic vessels and nerves, the hemorrhoidal branches of which pierce it in their course towards the anus. The masses of adipose and cellular tissue, from two to three inches in depth, which fill these spaces, impart a certain degree of firmness and elasticity to the parietes of the rectum and to this part of the pelvis, and are retained and supported in their situation by their connection to these fasciæ, as well as by the glutæi muscles which overhang them; in these spaces inflammation often occurs, and the consequent suppuration and abscess not unfrequently lead to the disease of fistula and ano. Next, examine the muscles in the anterior part of the perinæum; the erector or compressor penis is most external, and lies on the crus penus; the accelerator urinæ extends along the middle of the perinæum, attached to its fellow in the raphe, and covering the urethra; the transversalis perinæi connects the posterior extremities of these muscles. To these three pair some writers add three others, namely, the pubio-urethral, or Wilson's muscles, the ischio-bulbosi or transversi perinæi alteri, and the compressores penis, or Houston's muscles. I shall allude to each of these afterwards, though I do not approve of this arrangement. Immediately in front of the rectum, in the middle line, and behind, but connected to the bulb of the urethra, is a small spot, of condensed cellular, tendinous, and muscular substance; into this many of the perinæal muscles are inserted; it is, therefore, called the *central point* of the perinæum, or the *common point of insertion* to the muscles of the perinæum.

Erector, or Compressor Penis, long and flat, narrow at each extremity, broader in the middle, *arises* tendinous and fleshy from the inner surface of the tuber ischii, and from the insertion of the great or inferior sacro-sciatic ligament, the fibres proceed forwards, upwards, and inwards, adhering to the edges of the rami of the pubis and ischium, and covering the crus penis. The fleshy fibres terminate in a tendinous expansion, which inclines forwards, upwards, and outwards, and is *inserted* into the fibrous membrane of the corpus cavernosum, or crus penis; some of the fleshy fibres are continued upwards and inwards, and are inserted into the inner side of the crus. *Use*, to draw down the penis; it is also supposed by some to contribute to the erection or distension of this organ by propelling the blood into it, and by the compression of the dorsal vein of the penis, as well as of the veins of the crus, against the bone, preventing the free return of this fluid through these vessels; others, on the contrary, contend that it does not compress, but rather dilates the corpus cavernosum, by separating the lower from the upper wall, and that it thereby facilitates its distension or erection; the course and attachment of the fibres appear to me to favor the former opinion in preference to the latter, although I believe this muscle has little or no effect in producing this peculiar change in the erectile tissue of the organ: it is the most external of the muscles in this situation, it covers and adheres to the crus penis.

Accelerator Urinæ, or Ejaculator Seminis, is in the middle of the perinæum, extends from the front of the rectum to the back part of the scrotum, and is attached to its fellow along the mesial line; it *arises*, first, by tendinous fibres from the triangular or inter-osseous ligament, internal to the erector penis; secondly, by a thin tendon, which is common to the opposite muscle, and which lies above the urethra, between it and the pubis; thirdly, more anteriorly, by a tendinous expansion from the upper surface and outer side of the corpus cavernosum penis. The posterior and middle fibres descend inwards; the anterior fibres, which are longer, descend obliquely backwards and inwards; all the fibres are *inserted*, along with those of the opposite muscle, into the middle tendinous line or raphe of the perinæum, which extends from the common central point to the root of the scrotum. Or we may study

this muscle according to the following description: *arising* with its fellow from their common tendinous raphe, which commences in the central spot, adheres to the bulb, and extends as far forwards as the angle which the bent or flaccid penis and urethra form with the pubis; from this line the fleshy fibres of the two muscles diverge like the barbs of a feather, the posterior pass upwards and outwards, are convex and strong, form a capsule for the bulb, and are inserted into the triangular ligament, also sometimes into the rami of the ischium and pubis, above the crura penis; the middle fibres, which are short, encircle the urethra, and end in a common tendon on its upper surface, which adheres to it, and to the angle of the crura penis; the anterior fibres are the longest, diverge like the legs of the letter Y, ascend outwards and forwards along each crus penis, and end in a thin but tough aponeurosis, which spreads upwards and inwards, and is continuous with the suspensory ligament and fascia of this organ. *Use*, to expel the last drops of urine and semen; the posterior and middle fibres are supposed to have an influence in distending or erecting the corpus spongiosum urethræ by propelling the blood into its cells; and the anterior are also thought to contribute to the same effect, by their insertion into the fascia of the penis compressing the dorsal vein. The posterior origin of this muscle is overlapped by the compressor penis, and by the perinæal vessels and nerves; some of its fibres extend in some cases outwards, to the rami of the ischium and pubis, and are attached to the bone: the origin of the middle fibres lies above the urethra, and that of the anterior is external and superior to the crus penis. The acceleratores urinæ muscles fill up the middle of the perinæum, cover the bulb, and encircle the urethra anterior to it Separate these muscles from each other along the mesial line, and detach one of them from the corpus spongiosum urethra, then, by examining its deep surface, its origin, particularly that which lies above the urethra, and anterior to the bulb, will be more distinctly seen. The terminating aponeurosis of the anterior portions occasionally carry along with them some muscular fibres to the dorsum of the penis, and from the attachment of the former to the suspensory ligament these fibres sometimes appear like distinct muscles, and hence, probably, Mr. Houston was led to describe a pair of muscles in this situation under the name of

Compressores Venæ Dorsalis Penis; according to his account (Dub. Hosp. Rep. vol. v.) "these *arise* from the rami of the pubes, above the crura and erectores penis; they ascend inwards and forwards, unite, and are *inserted* in a common tendon above the dorsal vein in the median line; they form a thin, musculo-tendinous stratum, about an inch long and three-quarters broad, separated from the penis by the dorsal vein, arteries, and nerves; the pudic arteries, in their course to the dorsum of the penis, separate them from Wilson's muscles, or the anterior portions of the levatores ani. *Use*, to contract and close the vein, and thus, by mechanically obstructing the current of the blood, induce turgescence and erection of the organ."

These muscles, however, which are well developed in the dog and in many other animals, do not, I believe, normally exist in man; although I have, in some instances of young and robust subjects, seen the fibres above described, yet I think they are often very indistinct, and inadequate to the office assigned; when present, I am disposed to regard them as only rudimental of the more perfect structure in other animals.

Transversalis Perinæi is thin and weak, often indistinct, and sometimes wanting; it *arises* from the inside of the tuberosity of the ischium, above the erector penis muscle; the fibres pass transversely inwards, but also a little forwards and downwards, and are *inserted* into the central point of the perinæum, behind the accelerator urinæ muscle. *Use*, to fix the central point, and support and raise the anus; it assists in defæcation, by pressing backwards the anus and the forepart of the rectum, which are drawn forwards

and raised by the levatores ani muscles; it may also dilate the bulb. This muscle is covered by the sphincter ani, and by the superficial fascia; a small artery (transversalis perinæi) runs along its anterior edge; it lies on, or rather beneath the levator ani, and nearly parallel, connected to it by cellular membrane, and in some cases intimately joined to it; the two transversi are sometimes continuous with each other across the median line, in front of the anus, so as to resemble a semicircle concave backwards, embracing and compressing the forepart of the rectum. In some subjects a second muscle may be observed taking a transverse course (the *transversalis alter*, or *ischio-bulbosus*); this *arises* from the ramus of the ischium and pubis, proceeds obliquely forwards and inwards, and is *inserted* into the accelerator urinæ and side of the bulb; though shorter, it is often stronger than the superficial transverse muscle; it lies deeper and higher, that is nearer the pubis, and is partially concealed in the posterior part of the triangular or deep fascia of the perinæum; though not unfrequently a distinct fasciculus, it generally appears to me to be only a portion of the levator ani. The transversi perinæi muscles are very irregular in size in different persons, in some being found very distinct and strong, in others a few pale and scattered fibres only point out their course and situation; the dissector is frequently obliged to raise off a few fasciculi from the levatores ani muscles, to make even an appearance according with the description given in books. Between the three last described muscles on each side we may remark a triangular space, which is bounded externally by the crus penis and the erector penis muscle, internally by the urethra and accelerator urinæ; the base is posteriorly, and is formed by the transversalis perinæi muscle. This space contains a quantity of fat, also the perinæal artery, veins, and nerves, branches of the pudic vessels and nerves; into this space, near its base, on the left side of the perinæum, the operator must sink his knife in the lateral operation of lithotomy, in order to lay bare the groove in the staff. In this incision the transversalis muscle and artery of the perinæum must be divided. Next dissect off the erector penis from the crus penis, also the acceleratores urinæ muscles from the bulb and corpus spongiosum urethræ; detach the transverse muscle from its attachments, and remove the vessels and cellular membrane out of the triangular space just now described; then press the bulb of the urethra to one side, from the crus penis, and between these two bodies we may observe a strong ligamentous substance, the fibres passing in different directions; this is the *triangular ligament of the urethra*, or the *interosseous ligament*, or, according to some, *the deep fascia of the perinæum*. This is a strong aponeurosis, extended as a tense septum between the anterior part of the perinæum and the pelvis; of a triangular shape, its apex is thin, and lost in front of the pubic symphysis and subpubal ligament on the dorsal vessels of the penis; from this it inclines obliquely downwards and backwards, attached on each side to the rami of the pubis and ischium, above the crura penis; its base, or posterior inferior margin, which is weak and undefined, is directed towards the rectum, and is connected mesially to the central point, and on either side is continued behind the transversus perinæi, joins the middle perinæal aponeurosis and the ischio-rectal fascia, and is lost on the lower surface of the levator ani muscle; it is covered on its perinæal aspect by the muscles, nerves, and vessels of the perinæum, and by the bulb of the urethra; the vessels of the latter are inclosed between its laminæ; its upper or pelvic surface is in contact with a venous plexus and with the anterior portion of the levtor ani; about an inch below the pubic arch it is pierced by the urethra; this aperture corresponds to the angle between the bulb and the membranous portion of that tube, and from its margin are derived two laminæ or processes, one, anterior and inferior, is lost upon the bulb, which it serves to fix, support, and compress; the other, or the posterior lamina, is more extensive, is continued backwards into the

pelvis, around the membranous part of the urethra, and a delicate venous plexus, or spongy erectile tissue, and then expands to inclose the prostate gland · it is, therefore, of a funnel form, the apex towards the perinæum, the base is in the pelvis, superiorly it covers the upper surface of the prostate and neck of the bladder, and is beneath the pubic ligament and the dorsal veins of the penis, and joins the convex surface of the anterior ligaments of the bladder, or the anterior reflection of the pelvic fascia; laterally it forms a smooth, glistening capsule for the lobes of the prostate, and is attached to the convex edge of the lateral vesical. ligaments or folds of the pelvic fascia; inferiorly it extends backwards between the rectum and bladder, covers the prostate, vasa deferentia, and vesiculæ seminales, and is connected between the latter to the convexity of the pelvic *cul de sac*, or recto-vesical fold of the peritoneum; this portion of the fascia is very distinct and strong, and has been described by Mr. Tyrrel as a distinct lamina of the pelvic aponeurosis, under the name of the *recto-vesical fascia.* The triangular or interosseous ligament is an important texture in this region; it forms a septum or boundary to the lower and anterior part of the pelvis; it sustains and fixes the canal of the urethra in its passage to the perinæum, and it supports and strengthens the bulb or the commencement of its corpus spongiosum; by its attachments to the neck of the bladder and to the prostate gland, and by its continuity with the pelvic fascia, it serves to connect those organs to the pubes, and to retain them in certain fixed relations to the surrounding parts; by its connection, also, to the ischio-rectal fascia and levator ani muscle, it strengthens the inferior region of the pelvis posteriorly, and sustains this muscle and the rectum: as the pubic ligament intervenes superiorly between its two laminæ, so inferiorly these are separated by the arteries of the bulb and by two small glands, *Cowper's*, or the *anti-prostatic glands;* these may be next exposed by dividing a few fibres of the anterior layer of this ligament, and by a little dissection on each side of and a little below the bulb; these are two in number, each about the size of a small pea, situated at each side of and behind the bulb, below the membranous part of the urethra, between the layers of the triangular ligament, and closely connected to the artery of the bulb; they are covered anteriorly or inferiorly by the acceleratores urinæ muscles, and by the anterior layer of the triangular ligament; of a pale, reddish color, and of a firm tissue, resembling that of the salivary glands; they have no distinct capsule, and their form is therefore variable; from each a small, distinct duct, about an inch in length, passes forwards, and opens obliquely into the lower and lateral part of the urethra, at a little distance anterior to the bulb. Dissect away all the cellular membrane at the side of the rectum, between it and the tuber ischii; you will thus expose the greater portion of the levator ani muscle; press the rectum to the opposite side, and you will then observe how this muscle posteriorly, and the triangular ligament anteriorly, close the inferior opening of the pelvis, and separate this cavity from the perinæum; detach the crus penis from the bone on one side, and above it separate the triangular ligament on one side also from the rami of the pubis and ischium, and draw it over towards the bulb of the urethra, which, together with the rectum, press or fasten with a tenaculum, towards the opposite tuberosity of the ischium. In separating this ligament from the bone, the pudic artery and its terminating branches will be seen; we thus also expose the greater portion of the levator ani muscle on one side, and which, we may next examine, although, to understand the anatomy of the muscle fully, it must be examined in two other aspects; the present dissection displays its inferior surface, the course of its fibres and their insertion or perinæal attachment; its upper or pelvic concave surface may be seen by raising the peritoneum and the intestines it contains out of the pelvis, and carefully dissecting the thin reflections of the pelvic fascia from its fibres; and lastly,

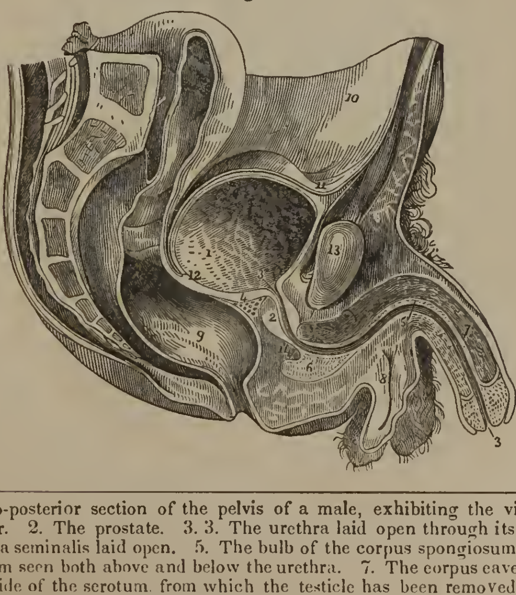
when the lateral dissection of the pelvis has been made (which we shall direct presently), the origin of the muscle on one side, and its relations to the rectum and neck of the bladder, will be fully displayed, in the course of which dissection the reader can again refer to the following description.

Levator Ani, flat, thin and broad, or irregularly square, situated at the inferior and lateral part of the pelvis, broader above at its origin than below at its insertion; *arises* by three origins, the first is fleshy, from the posterior part of the symphysis pubis below the true ligaments of the badder; the second is thin and tendinous from the obturator fascia, and from the inferior surface of that angle of reflection of the pelvic and vesical fasciæ, from which both the anal and obturator laminæ descend external to this muscle; its origin from the ilium is through the medium of the pelvic fascia; the third is thick, tendinous and fleshy from the inner surface of the ischium, and from its spinous process; the fibres descend obliquely inwards, by the side of the neck of the bladder and rectum; the anterior passing more backwards than the others, while the posterior are more transverse or horizontal; *inserted*, the anterior or pubic fibres into the central point of the perinæum, and into the forepart of the rectum, uniting with the fibres from the opposite side; these fibres descend along the side of the lower fundus of the bladder and of the prostate gland and membranous part of the urethra; the middle fibres are inserted into the side of the rectum, passing internal to the sphincters, and united to the outer surface of the longitudinal fibres of the intestine; the posterior fibres into the back part of the rectum, and into a tendinous raphe, extending from it to the os coccygis, in which raphe the muscles from opposite sides unite, also into the two last bones of the coccyx. *Use*, to raise and draw forward the rectum, particularly when this intestine has been protruded by the efforts of the abdominal muscles and diaphragm to expel its contents; it also assists in closing this intestine; it compresses the vesiculæ seminales and prostate gland, and assists powerfully in the evacuation of the fæces, urine, and semen; the anterior portion supports the perinæum by raising the common central point, and may also compress and close, like a sphincter, the membranous portion of the urethra; these muscles complete the inferior boundary of the pelvis and abdomen, and form a muscular floor to these regions, not unlike the diaphragm above, but opposed to it in respiration, being muscles of expiration; they resemble a funnel, with two openings in it inferiorly, the concavity directed towards the pelvis, the convexity to the perinæum, through the anterior aperture the urethra passes, through the posterior the rectum. On the perinæal surface of this muscle are placed the muscles, the triangular ligament, the anal fascia, and the adipose substance in the ischio-rectal space, of which we have already spoken, and which separates it from the obturator fascia and muscle; its pelvic surface is related to the bladder, prostate, and rectum, but is separated from these and from the peritoneum by the pelvic and vesical fasciæ above, and by a thin lamina from the latter, which may be named *rectal fascia*, below. As the diaphragm owes much of its physical strength to its serous investments, so the fasciculi of the levatores ani (many of which are weak and separated) are supported and connected by the aponeurotic sheath in which these muscles are inclosed on either side; this sheath is formed on its superior or pelvic aspect by the pelvic vesical, and rectal fasciæ (but which cannot be seen in the present stage of the dissection), and on the inferior or perinæal aspect by the anal or ischio-rectal aponeurosis; the sheath of one side is directly continuous with that of the opposite around the rectum posteriorly, and anteriorly through the intervention of the recto-vesical fascia, by which again this entire structure is attached to the triangular ligament of the urethra, and thereby maintained in such a state of tension as to afford resistance and strength to the inferior region of the perinæum and to the parietes of the rectum.

At the anterior edge of each levator ani muscle fleshy fibres may be observed to surround the membranous part of the urethra very closely. These fibres, particularly at their insertion, will in general be found so united to the levatores ani, that they may be considered as portions of these muscles; they have, however, been described differently by different anatomists, no doubt in consequence of the different appearances they present in different subjects, and from the different mode in which the dissection has been conducted. Mr. Wilson describes them as follows:

COMPRESSORES, or LEVATORES URETHRÆ; each *arises* by a narrow tendon from the inside of the symphysis pubis, about one-eighth of an inch above the lower edge of the arch, and at nearly the same distance beneath the anterior ligaments of the bladder, to which, and to the tendon of the opposite muscle it is connected by loose cellular membrane; the tendons, at first round, become flat as they descend, are parallel and in contact; they soon end in fleshy fasciculi, which separate and inclose the membranous part of the urethra, and folding beneath it, are again united, and are *inserted* into a narrow tendinous line, which is lost in the common central point of the perinæum, and in the posterior layer of the triangular ligament between the prostate and the rectum. *Use*, to compress, contract, close, and elevate the membranous portion of the urethra; these fibres encircle the narrowest part of the urethra, that portion which is just behind the bulb, and may, by their contraction during life, form such an impediment to the passage of an instrument into the bladder as may lead the surgeon to suspect the presence of a stricture, when in reality no alteration of structure exists. The origin of these muscles is occasionally distinguished from the levatores ani by some small veins which pass from the side of the neck of the bladder to join the trunk of the dorsal veins of the penis, but their insertion is confounded with these muscles in perinæo behind the bulb.

Fig. 52.*



* An antero-posterior section of the pelvis of a male, exhibiting the viscera *in situ*. 1. The bladder. 2. The prostate. 3. 3. The urethra laid open through its whole extent. 4. The vesicula seminalis laid open. 5. The bulb of the corpus spongiosum. 6 The corpus spongiosum seen both above and below the urethra. 7. The corpus cavernosum penis. 8. The right side of the scrotum, from which the testicle has been removed. 9. The rectum. 10. The peritoneum lining the abdominal muscles. 11. Its reflection on the upper surface of the bladder. 12. Its reflection from the posterior surface of the bladder on the rectum 13. The section of the symphysis pubis. 14. A line marking the situation of the triangular ligament.

To these perpendicular muscles Mr. Guthrie has added a pair of *transverse compressors, arising* narrow and tendinous from the rami of the ischium, they pass inwards and a little upwards, expand into a fan-like form, inclose the urethra, and are *inserted* into a common tendinous raphe on its upper and lower surface, extending from the prostate to the bulb, and connected to both. Mr. G. considers these as totally distinct from Wilson's muscles, which, according to him, descend only to the upper surface of the insertion of the transverse, and do not encircle the urethra, as Wilson and others have described. All this muscular structure is, in the adult, intermingled with a spongy, elastic, erectile tissue, and a fine, soft, adipose substance, not unlike that of the tongue, except for the preponderance of veins; the exact course and termination or attachment of the fibres is indistinct, and appears very variable in different individuals. I consider that these perpendicular and transverse fibres, as well as the transversus perinæi alter, may all be regarded as portions of the levatores ani muscles, which close the pelvis inferiorly, and form a floor extending on each side from the pubis round to the coccyx; the fibres of these thin and broad muscles are not always in close and parallel contact, but occasionally some cross others with more or less obliquity, forming imperfect but separate planes; some fasciculi are separated by the passage of bloodvessels and by aponeurotic septa from the adjacent fasciæ; these, by careful dissection, may be still further isolated, and made to appear as distinct muscles: in the child the structure is more simple and the urethral fibres more distinctly connected with the levatores ani muscles.

Let the student next replace the triangular ligament, &c., and then reconsider the several parts before him in reference to the operation of lithotomy; he has already examined the triangular space between the erector penis and accelerator urinæ muscles, into which the knife of the operator is to sink in order to reach the groove in the staff; this space having been fully opened, the staff can be plainly felt or seen passing above the bulb through the membranous part of the urethra into the bladder: behind and below the bulb is the rectum; and close to the rami of the pubis and ischium are the internal pudic vessels covered by the obturator fascia; the large artery from the pudic, called the deep transverse artery, or the artery of the bulb, may also be observed passing in the substance of the triangular ligament, about an inch below the symphysis pubis. Hence, then, in order to lay bare the staff without injury to the more important parts which surround it, we should endeavor to open the urethra as near to the base of the triangular ligament as possible, as we shall thus be most likely to avoid the artery of the bulb. Suppose the knife of the operator to be lodged in the groove of the staff, and then to be pushed along it into the bladder, the student will perceive that at that moment the posterior layer of the triangular ligament, the anterior fibres of the levator ani, the compressores urethræ, and the left lateral lobe of the prostate gland must be divided, and from this view he may also learn that the rectum will be protected from injury if the staff be well raised into the arch of the pubes, its groove turned a little to the left side, and the wrist of the operator depressed, so as to elevate the point of the knife, and thus direct it into the neck of the bladder. He may next learn in what direction the knife can be withdrawn with safety and effect, and what parts require to be divided; it is to be withdrawn slowly and steadily, in a direction backwards and outwards, nearly parallel to the line of the cutaneous incision, the edge so lateralized as to avoid cutting the rectum posteriorly, or the pudic artery externally. In this part of the operation the middle fibres of the levator ani must be divided, also the adipose substance on its perinæal surface. The student may next withdraw the staff from the bladder, and pass it again and again along the urethra into that cavity; he will soon perceive how apt the point of the instrument is to descend into the sinus of the bulb, and the necessity of de-

pressing the handle of the staff, in order to raise the point into the membranous part of the urethra; at the same time he should observe that the latter is about an inch below the arch of the pubes, and that therefore, the point of the instrument is not to be too much elevated, otherwise it may lacerate the upper part of the urethra, and injure some large veins that may be found in this situation. The student may now also examine what occupies the space between the urethra and the pubes; immediately above that canal is the upper portion of the triangular ligament, attached to the crura penis; behind and above this are one or two large veins from the dorsum of the penis; these enter the pelvis along the upper surface of the prostate gland; above these is a smooth dense ligament, the *pubic ligament*, which is attached to the lower edge of the symphysis pubis, and rounds off the angle between the opposite rami.

Posterior to the levator ani, and overlapped by the glutæus maximus, is the following small muscle:

Coccygeus, triangular, thin and flat, at the inferior and posterior part of the pelvis, behind and above the levator ani, and in front of the sacro-sciatic ligaments, *arises* narrow from the inner surface of the spine of the ischium and adjoining ligaments; the fibres expand along the inner or lesser sacro-sciatic ligament, and are *inserted*, fleshy and tendinous, into the extremity of the sacrum and side of the coccyx. *Use*, to support and raise the os coccygis in defæcation, and to assist in closing the inferior and posterior part of the pelvis; this muscle is between the levator ani and the glutæus maximus; is composed of aponeurotic and fleshy fibres; it is more distinctly seen within the pelvis, as it is covered posteriorly by the sciatic ligaments and glutæus maximus; its posterior margin reaches the lower edge of the pyriformis, while its anterior is continuous with the levator ani, and is only distinguished from it by difference in structure; its upper surface is concave, and in contact with the pouch of the rectum; its lower convex surface is related to the glutæus maximus muscle and to the sacro-sciatic ligaments.

Next, let the student divide the central point of the perinæum, separate the rectum from the bulb, and draw the former a little downwards from the bladder and prostate gland: he will thus expose the inferior or posterior surface of the neck of the bladder, the flat posterior surface of the prostate gland, also the vesiculæ seminales, the terminations of the vasa deferentia, and the commencement of the urethra; but the most important part to direct the attention to is a small triangular space or portion of the bladder, just above and behind the prostate gland, which is bounded on either side by the vasa deferentia and vesiculæ seminales, posteriorly by the *cul de sac* of the peritoneum, and anteriorly by the prostate gland, which forms the apex of this triangle; all these are covered by a strong aponeurosis, the posterior layer of the triangular ligament, or the recto-vesical fascia of Tyrrel; within this space, the bladder, when distended, is in contact with the rectum, and from the cavity of the latter the former organ may be perforated during life without injuring any important part; this space is about three inches and a half or four inches from the anus, and is selected by some surgeons as the best situation for tapping the bladder in case of retention of urine, when a catheter cannot be passed through the urethra. The student may now proceed to examine the pelvic viscera.

SECTION VII.

DISSECTION OF THE PELVIS.

The *pelvis* is the inferior portion of the trunk, continuous with and bounded above by the abdomen, with which it communicates so freely that some of the viscera of each may mutually occupy either situation; bounded on either side and in front by the ossa innominata, behind by the two last lumbar vertebræ, the sacrum, and coccyx, and closed below by the various tissues already described in the perinæum: it is divided into the upper or false, and the lower or true pelvis; the former cannot be separated from the abdomen, as it forms an essential portion of it, but the latter is distinguished from both by a well-marked line, formed posteriorly by the promontory of the sacrum, on either side by the ileo-pectineal ridge, and anteriorly by the cristæ and symphysis of the pubes. The anatomy of the pelvis, therefore, implies that of the *true pelvis*, which cavity is bounded behind by the sacrum and coccyx, in front and on either side by the pubis and ischium, and a small portion of the ilium; the sacrum is partially lined or covered by the pyriform muscles and sciatic plexus of nerves, the pubes by the pelvic fascia, and the sides by the obturator and pelvic fasciæ, the levatores ani, and internal obturator muscles. For the purpose of examining the viscera in this region, make the following dissection: separate the left crus penis, also the left border of the triangular ligament, from the rami of the ischium and pubis (if not already done), and detach the levator ani muscle of the left side from its pelvic attachments; with the hand separate the cellular and aponeurotic bands, which lie superior to this muscle; then divide the symphysis pubis, or saw the left os pubis about a quarter of an inch external to the symphysis; divide the left ilio-sacral articulation, cut through the psoas muscle and iliac vessels, and then remove the os innominatum and lower extremity of the left side; the pelvic viscera will remain in the concavity of the sacrum and of the os innominatum. These viscera will be rendered more distinct by a little preparation; first, moderately inflate the bladder through the ureter, a ligature having been tied around the penis, the rectum also may be moderately distended with curled hair or a sponge, and attached to the spine by a ligature. The *pelvic portion* of the *peritoneum* should be first attended to. This membrane may be now seen to descend along the sides and forepart of the rectum to within about four inches of the anus, whence it is reflected on the lower and back part of the bladder, a little above the base of the prostate gland; the line of this reflection is, in the recumbent position of the subject, opposite the lower margin of the third piece of the sacrum; in the erect posture it will be found on a level with the junction of the sacrum and coccyx; it is reflected on the bladder between the middle of the vesiculæ seminales; it then ascends on the back part and sides of this organ to its superior fundus, whence it is continued to the abdominal muscles. Below the line of its reflection, or below the *cul de sac*, we may again take notice of the small triangular space on the inferior fundus of the bladder, before alluded to, as the situation in which that viscus can be punctured from the rectum, in case of retention of urine. The reflections of the peritoneum, from each side of the rectum to the back part of the bladder, are called the posterior ligaments, and the folds which this membrane forms, one on each side between the bladder and the iliac fossa, are named the lateral ligaments of the bladder; these shall be more particularly noticed presently. The *pelvic fascia* may be considered as a continuation of the iliac; it descends behind the iliac vessels, from the brim of the pelvis, to which it adheres, lines the parietes of the

cavity as low down as the upper edge, or the origin of the levator ani muscle, and divides into two laminæ, between which this muscle is inclosed; the external is named the obturator, the internal the vesical fascia.

The *obturator fascia*, or lateral pelvic aponeurosis, descends between the obturator internus and levator ani, adhering closely to the former, and sends off the ischio-rectal or anal fascia, which covers the perinæal aspect of the levator ani muscle; the obturator fascia is inserted inferiorly into the projecting border or falx-like process of the great sciatic ligament, into the tuber ischii, and into the rami of the ischium and pubis, where it is continuous with the triangular ligament of the urethra, which ligament thus appears to be the continuation of the obturator fascia, from one side of the pelvis to the other; it is also connected posteriorly to the overhanging border of the glutæus maximus, and to the coccygeus muscles: its external surface is in contact above with the obturator internus muscle, which separates it from the obturator ligament or membrane and from the bone, inferiorly with the great pudic vessels and nerves, which it incloses in a sort of sheath, and which are thereby protected from injury in the lateral operation of lithotomy; its internal surface is in contact above with the levator ani muscle, but separated from it below by the anal fascia, and by the adipose mass which fills the ischio-rectal space, of which latter it forms the outer wall; the obturator fascia is better seen in the dissection of the perinæum, where it has been already noticed (page 259).

The *vesical fascia*, or superior pelvic aponeurosis, covers and adheres to the internal surface of the levator ani, lying between it and the peritoneum; in order to see it, the latter must be removed together with the loose connecting cellular tissue, which readily admits of being torn from it; it may also be exposed on its perinæal aspect, by dividing the levator ani muscle and its investing fasciæ, also the triangular ligament of the urethra; this fascia descends, anteriorly, to the lower edge of the symphysis pubis, and laterally to a level with a line carried from this point round to the spine of the ischium; from the pubes it is reflected on the upper surface of the prostate gland, and on the neck of the bladder, forming the anterior true ligaments of this organ; laterally it is reflected from the pelvis on the side of the prostate, and on the lower part of the side of the bladder, just above the outer edge of each vesicula seminalis, and thus forms the true lateral ligaments of the bladder; posteriorly it is thin and cellular, and lost on the forepart of the sacrum, and on the nerves and vessels passing into and out of the pelvis. As this fascia is reflected upwards on either side to form the true lateral vesical ligaments, it incloses the vesical venous plexus, and sends off from its inferior or convex surface two processes or laminæ; one passes inwards and a little downwards, beneath the vesiculæ and the bladder, in front of the rectum, and joins a similar process from the other side; this may be named (according to Tyrrell) *recto-vesical fascia*, or, if this latter be considered as derived from the posterior layer of the triangular ligament of the urethra (see page 262), then this process may be considered as a mere connecting lamina between it and the vesical fasciæ of each side; the other process descends more directly on the upper or pelvic surface of the levator ani to the lower part of the rectum, on which it expands, and meets posteriorly the similar process from the other side, so as to invest it laterally and behind; this process may be named the *rectal fascia*, and is not to be confounded with the anal or ischio-rectal, which covers the opposite or inferior surface of the levator ani; the rectal fascia on either side and behind, together with the recto-vesical in front, form a complete aponeurotic investment for the lower portion of the rectum immediately above the insertions of the levatores ani muscles. The vesical fascia, therefore, on each side, may be described as dividing at the outer border of the vesicula, where it incloses a venous plexus, into three processes or laminæ: a

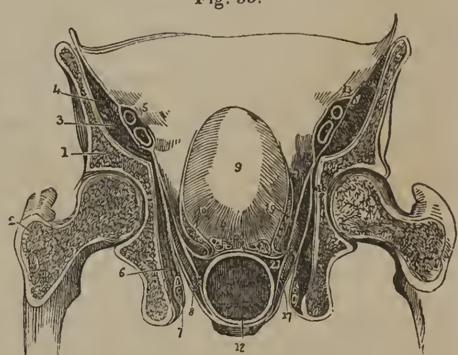
superior, the true lateral vesical ligament; a middle, the recto-vesical fascia; and an inferior, the rectal fascia: at its anterior reflections it is short and very strong, and presents the appearance of two flat tendons, with an intervening depression, passing in an arched manner from the pubes to the neck of the bladder, and continuous with the muscular fibres of the latter; its long lateral reflection often presents the appearance of a strong tendinous arch extending from the pubis, beneath the canal for the obturator vessels, as far back as the spine of the ischium.

The vesical fascia forms a pouch on each side of the bladder, which assists in closing the pelvis; it also fixes the pelvic viscera, supports the peritoneum, and resists the pressure of the abdominal muscles and diaphragm, and thus prevents perinæal hernia; it separates the perinæal from the pelvic or subperitoneal cellular membrane, and limits the progress of inflammation, or infiltration from the former to the latter; its reflection on the prostate and neck of the bladder is superior to the line of the lateral incision in lithotomy through these parts, and therefore the pelvic cellular tissue is uninjured. This fascia is perforated by several bloodvessels, anteriorly the small vesical and prostatic, posteriorly the sciatic and pudic: there are also often small depressions and deficiencies in it filled with fat. At the anterior border of the great sciatic notch, it forms an arched boundary to the opening for the escape of the great glutæal vessels and nerves; when sciatic hernia occurs, it is through this opening and behind this arch. Divide the pelvic fascia on one side, in the course of its lateral reflection, and the levator ani muscle will be exposed, particularly its origin, to the account of which the student may refer (page 264); the rectum, ureter, and vas deferens, also come into view, and deserve particular attention; these should be all carefully dissected, but disturbed as little as possible from their natural relations. The course of the ureter has been already described; the vas deferens will be noticed hereafter with the generative organs; but now remark the curved course of the rectum, its dilatation above the anus, the connection of the peritonæum to its upper and middle thirds; and its lower third, below and wholly unattached to this membrane; this portion is curved so as to be convex towards the prostate, concave towards the coccyx, and as the anal end of the intestine inclines backwards, it leaves between its forepart and the urethra a triangular space (*recto-bulbar*), bounded above and before by the membranous portion and bulb of the urethra, behind by the rectum between the prostate and the anus; the integuments, together with the central point of the perinæum and the muscles inserted therein, form its base below; this space is traversed laterally by the knife in lithotomy, and if the convexity of the rectum, or its dilatation, be greater than usual, it is in danger of being wounded; in the child, this lower curve or anterior convexity of the rectum is not developed, as the intestine is almost straight, or a little concave forwards. In the adult or old the dilatation of the rectum above the sphincters is often very considerable, particularly in front; to it the prostate gland, vesiculæ seminales, and "bas fond" of the bladder, are connected by cellular tissue, in which a number of very large and tortuous veins may be observed. Next study the connections of the urinary bladder.

Vesica Urinaria is a musculo-membranous sac, the temporary receptacle for the urine, which constantly trickles into it from the ureters; it is also the chief agent in the expulsion of this fluid from the system by the urethra, being assisted by the abdominal muscles and the diaphragm; situated in the median line, and, to a certain extent, a fixed viscus, its exact position and relations, as well as shape, must vary according as it is contracted or enlarged; the latter also varies with age, and, in some measure, with sex. In the adult, in its contracted state, it is deeply sunk in the anterior and inferior part of the pelvis, behind and below the pubes, and is then of a flattened triangular

form, the base towards the rectum, the apex behind the lower edge of the symphysis; when moderately enlarged it becomes of an ovoid form, the larger end resting on the rectum, the smaller and anterior being towards the recti abdominis muscles between the pubes and the peritoneum; when fully or over-distended the superior or abdominal end rises still higher in the abdomen, and enlarges more and more, so that the larger end of the oval is then above and the smaller end below in the pelvis. In the adult female, especially if she have borne children, the bladder has greater general capacity than in the male, is flattened before and behind as if by the pressure of the uterus and the pubes, and the transverse diameter is longer. In the infant it is pyriform, the large round end, or fundus, above in the hypogastric region of the abdomen, the small tapering neck below the pubis: this fact accounts for the term "fundus" being applied to the "summit" of the organ, which is not only inaccurate as to language, but is really incorrect, as applied to the adult, for the base or fundus is then in the pelvis: the long axis of the bladder is a line directed obliquely downwards and backwards through its cavity from one extremity to the other; its obliquity is increased in proportion as the organ is distended and raised out of the pelvis; it will then correspond to a line drawn from the coccyx to midway between the umbilicus and the pubes. When the trunk is slightly inclined forwards, the cervix is the most depending part; but in the erect, and still more so in the horizontal posture, the "bas fond" is on a plane inferior to the urethral opening, at least in the adult; in the child, however, the bladder being pyriform with the large end above, the "bas fond" is not developed, and the orifice is the most depending part. The bladder is connected to the parietes and to the viscera of the pelvis by folds of the peritoneum, and by the reflections of the pelvic fascia. The former are termed false ligaments, and are five in number, viz., two posterior, two lateral, and one superior; the latter are reflections of the pelvic fascia, and are four in number, two anterior and two lateral. The *false ligaments* are, first, the two *posterior*, one on each side, leading from the front of the rectum to the back part of the bladder, semilunar, concave forwards and

Fig. 53.*



* A posterior view of a transverse section of the pelvis, showing the arrangement of the different layers of fasciæ in the pelvis. 1. Section of the os innominatum. 2. Section of the upper extremity of the femur. 3. The iliacus internus and psoas muscles. 4. The divided extremity of the anterior crural nerve, external to the sheath of the vessels. 5. The external iliac artery and vein. 6. The obturator internus muscle. 7. The internal pudic vessels and nerve. 8. The levator ani muscle. 9. The bladder. 10. The vesical plexus of veins. 11. The vesicula seminalis of one side. 12. The rectum. 13. The iliac fascia, covering the iliac and psoas muscles, and separating into two layers external to the vessels, so as to form a sheath for them. 14. These two layers, reuniting beneath the vessels to form the pelvic fascia, which having descended into the pelvis, divides into 15, the vesical fascia; and 16 the obturator fascia, descending on the obturator internus muscle to the tuber ischii and forming a sheath for the internal pudic vessels and nerve. 17. The anal or ischio-rectal fascia, given off by the obturator, and investing the inferior surface of the levator ani. 18. The vesical fascia, splitting into three laminæ. 19. Its ascending lamina, forming one of the lateral ligaments of the bladder. 20. Its middle lamina, the recto-vesical fascia of Tyrrell, passing beneath the vesiculæ seminales and between the bladder and rectum. 21. Its inferior lamina, the rectal fascia, surrounding the rectum, and meeting the fascia of the opposite side in the mesial line.

upwards; in each is contained the ureter posteriorly, and the obliterated hypogastric artery anteriorly; between these ligaments the recto-vesical *cul de sac* of the peritoneum descends; one or two semilunar folds usually exist on the posterior surface of the bladder, if in a state of contraction; these disappear, however, when it expands, and are therefore designed to admit of its more easy distension. The two *lateral* extend from its sides to the iliac fossæ; each contains in its duplicature the vas deferens in the male, and the round ligament of the womb in the female. The *superior ligament* extends from the summit of the bladder to the recti muscles, and is partially reflected over the remains of the urachus and umbilical vessels. Detach the peritoneum from the right iliac fossa, and gently draw the bladder and rectum from the pelvis, we shall then observe that the neck and sides of the former are retained in their situation by the reflections of the pelvic fascia from the parietes of the pelvis upon this viscus; these are the *true ligaments* of the bladder.

The *anterior*, two in number, *arise* from the lower margin of the pubis by the side of the symphysis, pass backwards and upwards on the upper surface of the prostate gland, and expand on the anterior part of the bladder, with the muscular fibres of which they become partly continuous; their inferior or convex surface is united to the posterior layer of the triangular ligament; a depression exists between them, along which the dorsal veins of the penis pass from beneath the arch of the pubes to the side of the bladder in their course to the internal iliac veins; the fascia, however, is not deficient between these ligaments, but is continued from one to the other, so as to line this depression and cover the veins. The *true lateral ligaments* are one on each side; each is continuous with the anterior, and is formed by the reflection of the pelvic fascia from the inner surface of the levator ani to the side of the prostate gland and of the bladder, and incloses the vesical venous plexus.

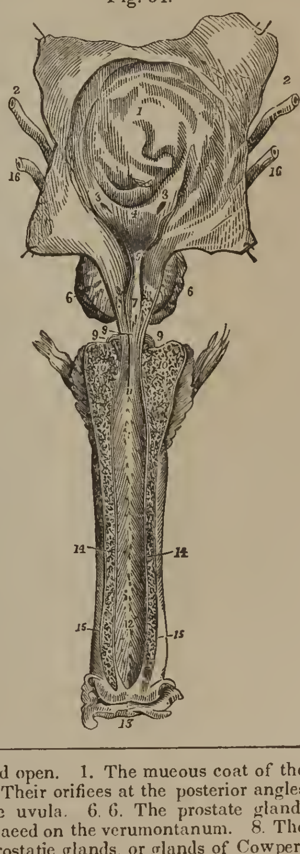
The superior anterior extremity is named the *superior fundus;* the posterior, which presses against the rectum, the *inferior fundus*, or "bas fond;" the intervening portion, the *body;* and that part which is connected to the pubes, and is above the rectum, the *cervix;* the latter is surrounded by the prostate gland, but little, however, of the latter being above it; the cervix is somewhat conical; in the adult it lies nearly horizontal, below and behind the pubes; in the child it is more vertical or oblique. There is no exact distinction, however, between these several compartments, and a more accurate knowledge of the organ may be obtained by examining the several aspects or regions it presents when moderately distended, which are six in number, and on each of which some important object may be noticed. 1st, The *superior region* is in contact posteriorily with the convolutions of the small intestines, and anteriorly with the recti muscles; to it are attached the urachus and obliterated umbilical arteries; posterior to which, only, it is covered by the peritoneum; if much distended, this region is sometimes found to incline to the left side. 2nd and 3rd, The *lateral regions* are contiguous to the sides of the pelvis, to the vesical fascia, and to the levatores ani muscles; descending obliquely backwards along this region is the vas deferens, crossing over the umbilical artery above, and the ureter below, passing internal to both, or nearer to the mesial line; the peritoneum adheres to so much of each lateral region as is posterior to the vas deferens, while that portion anterior to it is deficient of serous covering. 4th, The *anterior region* also looks a little downwards; it is behind the recti muscles, the pubes, the pubic ligament, and the triangular ligament of the urethra; all this region wants the peritonæal covering; towards its inferior part we observe the anterior ligaments of the bladder, between these the dorsal veins of the penis, and below these the neck of the bladder surrounded by the prostate gland. 5th. The *posterior region* is contiguous to the rectum in the male, to the uterus in the female, and in either sex occasionally to the convolutions of the small intestines: all this region is

covered by peritoneum. 6th, The *inferior region*, in the female, lies on the ureters and on the vagina; in the male, on the vesiculæ seminales, the intervening *cul de sac* of peritoneum, the rectum, and the prostate gland; the superior and posterior part of this region is covered by the peritoneum; but anterior to the line of the reflection of this membrane from the bladder to the rectum, is the triangular portion of this region, in which the peritoneum is deficient, and which has been already attended to, as the situation in which the operation of tapping the bladder from the rectum may be performed. In the contracted state of the organ, the peritoneum descends almost to the prostate gland, and nearly covers all this space; but in the distended state not only is the latter much enlarged, but the peritoneum is raised out of it posteriorly, so as to allow the bladder and rectum to come in contact. It is composed of five tunics or laminæ, three of which are essential or proper, serous, muscular, and mucous; these are connected by two laminæ of cellular tissue. The *serous* is but a partial coat, covering those portions only which come into contact with other movable viscera, namely, the posterior region, the back part of each side, and of the upper and lower fundus; all the anterior region, the cervix, the forepart of the sides and fundus, are, therefore, uncovered by peritoneum; when distended, there is more of it in proportion covered by this membrane than when it is contracted; it is dense and strong, and can be easily detached from the muscular coat, to which it is connected by the first or *external cellular tunic;* this lamina, in some situations is compact and elastic; in others, as in front, it is loose and abundant, to allow the bladder to rise out of the pelvis; inferiorly it contains several veins, partially envelopes the vesiculæ seminales, and is continued to the forepart of the rectum; it contains but little adipose substance; bloodvessels and nerves ramify and divide in it in their course to the other textures; it serves to connect the serous to the muscular coat, and to support and bind together the fibres of the latter. The *muscular coat* consists of fasciculi, arranged in such different directions as to admit of partial separation into two or three laminæ, longitudinal, circular, and reticular; they are very variable as to strength and color, but in these respects they surpass those of other hollow viscera, except the heart and œsophagus; the first or longitudinal are the strongest and most numerous, proceed from around the cervix, and expand over the entire surface; those on the forepart are connected superiorly to the urachus, and inferiorly to the anterior ligaments, and through these, as by shining tendons, to the pubes; hence some have described this lamina as a distinct muscle, "detrusor urinæ," but incorrectly; some pass deeper, and are inserted into the cellular tissue about the prostate, and some still deeper into the fibromuscular tissue of the cervix, whereby they are enabled to expand the sphincter during their contraction, and so allow the escape of the urine; laterally, these fibres are inserted into the prostate and its investing fascia; and, posteriorly, they are weak and scattered above, but below and between the ureters they form a strong, broad, and flat band; several fibres are inserted into the trigone, into and around the ureters; on the latter some even ascend in a retrograde course; no fibres pass over the vesiculæ seminales as over the prostate, but between these a distinct lamina descends to the base of the prostate, into and beneath which the fibres are inserted into the submucous tissue; one fasciculus can be traced mesially beneath the uvula as far as the verumontanum, under which it is inserted by a delicate tendon; the effect of these fibres must be to depress the uvula, also to depress and retract the verumontanum, and thereby protect the latter from the irritation of the urine, and at the same time open the orifice of the urethra freely for the passage of this fluid: in the female these longitudinal fibres are inserted anteriorly and laterally into the cellulo-vascular and glandular tissue around the cervix, and posteriorly into a more dense tissue, connecting the urethra to the vagina;

the longitudinal fasciculi are frequently crossed by transverse and arched bands, particularly in front, where also they often decussate in the median line, and then pursue a different course; this lamina may, by careful dissection, be raised in some places to some extent, particularly before and behind and below, but not uniformly throughout. The next order of fibres is circular; these are pale and scattered, particularly above, but as they approach the cervix they become more close and distinct, and have been considered by some as the "sphincter vesicæ," but there is no distinction between these and those above them, which are plainly designed to contract the organ; this term, therefore, is probably incorrectly applied. The circular or transverse fibres are very distinct posteriorly between the two ureters, and a strong semilunar band, concave backwards, forms the base of the trigone in front of the pouch or "bas fond," which is generally well developed in the adult and aged. This band can be better seen when the bladder is opened; it is impossible to raise these circular fibres as a distinct plane, as so many deviate from this direction and join deeper fibres in a tortuous or irregular course. The third set of muscular fibres are best seen from the internal surface; they project through the mucous membrane as distinct fasciculi, large and separate, and most irregularly arranged, so as to present a reticulated or honeycomb appearance; they are often very large, and, though paler, are not unlike some of the carneæ columnæ of the heart; they take various directions, divide, join again, subdivide, and unite with some of the other planes; when hypertrophied, these fibres often project considerably into the cavity, causing proportioned depressions or pouches of the membrane between them. This condition is named the columnar bladder, and the pouches, which often become dilated, like offsets with narrow, constricted mouths, are true herniæ of the mucous coat. This condition is named the sacculated bladder. In these sacs calculi are sometimes lodged, and one of them may undergo such gradual enlargement and lateral elongation as to become engaged in femoral or inguinal hernia. The neck of the bladder presents a peculiar structure; there is no exact limit to this part, hence the term is differently applied by different writers: some include as cervix all that portion in front of the recto-vesical reflection of peritoneum; others consider it so much only as is surrounded by the prostate gland: but most regard this as the first division of the urethra. There is, therefore, no exact limit or external mark to define this part, although it is one so generally alluded to. We consider as the neck that contracted, conical portion of the viscus, longer below and on the sides than above, which is embraced inferiorly and laterally by the base of the prostate gland, and laterally and above by the peculiar contractile structure which fulfils the office of a sphincter; this part contains internally and below, the slight elevation called the uvula or "luette," which lies over the middle lobe of the prostate gland; the contractile tissue is muscular, also fibrous and elastic, as well as vascular and nervous; it surrounds three-fourths of the orifice; the muscular fibres are red and close, are attached to the fibrous basis of the trigone on each side of the uvula, behind which they do not pass; they are not continuous with the circular plane, but the longitudinal fibres are partly inserted into this semicircular muscle, in the same way as the levatores intermingle with the sphincter ani; it is partly elastic, but essentially muscular; bounds the urethral opening laterally and above, but not below: the slight projection of the uvula in the latter situation, and the elasticity and tonic contraction common to all sphincters, preserve the opening in a closed state, and the urine is thus retained in the bladder, the muscular coat of which is in a passive and relaxed state; when distension excites the usual feeling, the general muscular coat contracts towards the pubis and cervix, and the longitudinal fibres draw out from the axis of the opening the relaxed sphincter which encompasses three-fourths of it, while the long middle band will

depress the uvula and retract the seminal caruncle, and thereby free the passage into the urethra. At the anterior part of the inferior region there is a compact layer of white, dense, fibrous substance, into which the muscular particularly the longitudinal, fibres of the bladder are inserted, but which itself does not appear to be very muscular, except near the cervix; this structure will be found to correspond with a particular region, to be noticed presently, in the interior of the bladder, called the trigone, or velum. Beneath the muscular is the fourth, or the *deep cellular coat;* it invests the whole organ, is very elastic, and seldom contains any adipose substance; it supports and strengthens the mucous lining, and contains the nutrient vessels and nerves. Open the bladder by a perpendicular incision through its anterior part, and the fifth, or *mucous coat,* will be observed, pale, and thrown into many folds, chiefly transverse, particularly if the bladder had been empty, for this membrane has no concractile power; through it the muscular fibres project, presenting a reticulated appearance, and very frequently the mucous membrane forms pouches, or small sacs, between these: inferiorly is seen the orifice of the urethra, somewhat of a crescentic figure, the uvula projecting into it from below; posterior to this the membrane presents a smooth and dense appearance throughout a small triangular space called the *velum* or *trigone;* at the posterior angles of which are the orifices of the ureters; the line extending between these forms the base of this triangle, is somewhat semilunar, and contains strong muscular fibres; the sides are defined by lines drawn from each ureter to the uvula from an inch to an inch and a half in length; beneath the membrane covering, these pale muscular fibres may in general be found; these have been named by Mr. Bell the *muscles of the ureters,* who describes each as *arising* from the vesical extremity of the ureter, and thence descending obliquely forwards and inwards, to be *inserted* by a tendon common to its fellow into the uvula. The *use* which he assigns to them is, to restrain the termination of the ureters, and preserve the obliquity of the passage of these tubes through the coats of the bladder while it is being contracted; for, says he, without this provision, the urine would be sent retrograde into the ureters, instead of forward into the urethra. These lines, however, seldom present this structure so distinctly as has been described, and how far their supposed use is correctly ascribed to them is very questionable.† The

Fig. 54.*



* The urinary bladder and canal of the urethra laid open. 1. The mucous coat of the bladder thrown into folds. 2. 2. The ureters. 3. 3. Their orifices at the posterior angles of the trigone. 4. The base of the trigone. 5. The uvula. 6. 6. The prostate gland. 7. The prostatic portion of the urethra, the figure is placed on the verumontanum. 8. The membranous portion of the urethra. 9. 9. The antiprostatic glands, or glands of Cowper. 10. 10. The bulb of the urethra. 11. The spongy portion of the urethra, the figure is placed on the sinus of the bulb. 12. The fossa navicularis. 13. The orifice of the urethra. 14. 14. The corpus spongiosum urethræ. 15. The corpora cavernosa penis. 16. 16. The vasa deferentia.

† See art. "Bladder," Todd's Encyclop. of Anat. and Phys.

uvula is a small eminence at the apex of the trigone, much better marked in some than in others; nearly opposite, but a little anterior to the third or middle lobe of the prostate gland, it appears little more than a slight fulness or prominence of the membrane, with an increase in the submucous tissue, which contains some follicles; it is vascular, and probably possesses some special organization, which endows it with peculiar sensibility and associates it with the entire organ; it assists in closing the urethral opening, but is effaced in a great measure by opening the cervix from the urethra when the bladder has been removed from the body, as the membrane is easily extended; but if only a small opening be made in the upper part, and we then look down towards the urethra, it appears as a small eminence in the median line, which it thus assists to close: it is smaller in the female; hence the urethral opening is larger than in the male. Throughout the area of the trigone the membrane is free from rugæ, but often marked with fine striæ, which converge to the urethral orifice, giving to the latter a puckered appearance. It usually presents a delicate rose tint, being variegated with fine vessels; with the aid of a magnifying lens numerous villi can be detected; it appears delicately and peculiarly organized, and is, no doubt, the most sensible part of the internal surface; beneath it is a dense substratum of fibro-cellular tissue, exterior to which the longitudinal muscular fibres are very distinct, and many are inserted into it, but very few of the circular or reticular can be detected; it is also supported by the vasa deferentia, vesiculæ, and prostate; this portion is so firm and incompressible that the cavity corresponding to it cannot be wholly obliterated, so that in the most perfectly contracted state it will still retain a few drops of urine; posterior to it the bladder is frequently, particularly in old subjects, dilated into a sort of pouch, which rests upon the rectum, and is so much below the level of the trigone that it is necessary, when sounding the bladder for the detection of a stone, to raise the handle of the instrument, and thus depress the point into this space, or the finger introduced into the rectum may raise forward this pouch, and thus strike the stone against the sound. In the female the trigone is smaller, less firm and distinct, but broader in proportion, than in the male, and the uvula is less developed.

The vesical arteries are variable as to origin, number, and size; they arise from the internal iliac, pudic, and obturator; the veins form a remarkable plexus around the cervix, which extends along the sides of the inferior fundus and vesiculæ seminales, and opens into the internal iliac, or some of its branches; the nerves are derived both from ganglionic and spinal filaments of the hypogastric plexus; accordingly the mscular power is partly involuntary and partly under the influence of the will.

This organ is by no means essential to the urinary secretion, and is absent in many animals; it is merely intended as a reservoir for the urine, and to act in its expulsion, in which it is the chief agent, for when its muscular coat is in a state of paralysis the most violent action of the abdominal muscles and diaphragm is unable to empty it of its contents.

The bladder is occasionally found in a *diseased* state; inflammation of it (cystitis) may be general or confined to one particular part; the portion which is most frequently so affected is that near the neck, and commonly arises from the presence of a rough stone; from the naturally pale appearance of the mucous membrane in the dead body any crowding of vessels containing arterial blood which takes place in inflammation, makes this state of parts easy of detection, and this is the case in chronic inflammation or catarrh of the bladder: if the inflammation be violent, the muscular coat may become engaged, and abscesses and ulcers are not unfrequently the consequence; they sometimes proceed so far as to destroy a portion of the bladder, and form communications between it and the neighboring viscera; with the rectum in

the male, and vagina in the female; they have also been known to open into the cavity of the abdomen, producing peritonitis and death from extravasation of urine; abscesses about the neck of the bladder are generally found as a consequence of the operation of lithotomy or of fatal retention of urine, or diseased prostate gland. The uvula, like other similar portions of mucous texture, is subject to infiltration and increase of size in acute inflammatory affections, as also to chronic enlargement, and closely simulates disease of the middle lobe of the prostrate gland. Calculi are not uncommonly formed in the bladder, their formation is confined to no particular period of life; they are found in very young children and in persons of middle and advanced age; they are less frequent in females, as the size of the urethra in that sex allows them to be discharged before they become large, probably also the tendency to their formation is not so strong. The stones which are found in the bladder are either originally formed in the kidneys, and pass through the ureters into the bladder, or they are at first formed in the bladder itself. Calculi lie either loosely in the cavity or are confined to some fixed situation from particular circumstances; when they are of a small size they are sometimes lodged in pouches, formed by the protrusion of the mucous coat between the muscular fasciculi. Urinary calculi have sometimes a smooth, uniform surface, but more frequently they are granulated and rough.

The urethra is the next division of the urinary organs to be examined; as this canal, however, in the male, is the common passage for the urine and semen, and a part both of the urinary and generative organs, we shall postpone the description of it until we have considered the latter.

SECTION VIII.

DISSECTION OF THE ORGANS OF GENERATION IN THE MALE.

These are the testicles and their appendices, the vesiculæ seminales, the prostate and anti-prostatic glands (the latter have been already examined,) the penis, and the urethra. The testes secrete the seminal fluid, the vasa deferentia conduct this to the vesiculæ seminales, whence it is coveyed, together with the secretion of these organs, by the ejaculatory ducts, into the urethra; the secretions from the prostate and anti-prostatic glands are added to it, but equally belong to this canal as a common passage for the urine, as well as semen; finally, the urethra is inclosed in a spongy erectile tissue, to which is added the analogous structure of the two crura penis, whereby it is adapted for the final expulsion of the seminal fluid. We shall describe these organs in the following order: 1st, the testes with their coverings; 2nd, the vasa deferentia; 3rd, the vesiculæ seminales; 4th, the prostate gland; 5th, the penis, and 6th, the urethra.

1st. The *Testes.*—These two glands are, during the greater part of uterine life, contained in the abdomen beneath each kidney; some time, however, previous to birth, they descend into that situation which they are found to occupy in the adult, and are surrounded by several tunics, viz, the scrotum, dartos, superficial fascia, tunica communis, vaginalis, albuginea, and vasculosa; the three first are common to both, the others are proper to each testis.

The *Scrotum* is a loose process of integument continued from the inner side of each thigh, and from the perinæum and penis; it is generally of a dark brown color, thinly covered with oblique hairs, the white bulbs of which project upon the surface; it usually presents numerous wrinkles, and is so

thin that the subcutaneous veins and sebaceous follicles can be seen through it; these latter secrete the peculiar perspirable matter of this region; the prominent hard ridge or raphe is continued from the perinæum along its middle line as far as the penis. In the old and enfeebled, or under the influence of warmth, it is soft, flaccid, and elongated; but in the robust, or when exposed to cold, it becomes rugous and closely contracted around the testes. and deeply indented between them; certain mental and nervous emotions also induce similar changes, which most probably depend upon the action of the subjacent tissue, the dartos, rather than upon the skin itself.

The *Dartos* is the peculiar cellular tissue immediately subjacent to the skin; it usually presents a reddish appearance; a number of small vessels are distributed through it; its texture is very loose, and is readily distended in emphysema, or in anasarca; it never contains any fat; it is somewhat more dense in the mesial line than at either side, is connected to the rami of the pubes and ischium, and to the raphe in the middle, thence it ascends a short way between the testes to the urethra, and thus assists the superficial fascia in forming the *septum scroti*, which divides this pouch into two lateral portions, of which the left is generally the longer; some describe the dartos as double, one for each side; the dartos manifests during life a degree of contractility above that which cellular tissue enjoys in any other situation; it possesses the power of corrugating the skin, and moving the testes in a sort of vermicular or peristaltic manner, distinct from the upward motion of these glands produced by the cremaster muscles; anteriorly and laterally, it ends abruptly in the cellular and adipose tissue of each femoral and inguinal region; in the middle it is continued round the penis, and can be sometimes traced even to the prepuce; posteriorly it extends near to the anus, and often derives a few muscular fibres from its sphincter: it is composed of thin areolar tissue, traversed by nerves and vessels, and intermingled with fine, soft, reddish filaments, which are interlaced in an irregular manner; some fibres are transverse, but the most are vertical; these resemble the involuntary muscular fibre in being unstriped, and in the effect of acetic acid bringing into view the peculiar corpuscles they contain, and which distinguish them from the white and yellow fibrous elements of the areolar tissue: the dartoid then appears to be a peculiar tissue intermediate between cellular and muscular: a somewhat analogous texture most probably pervades certain other parts, viz., the vagina, the nipple, the coats of some excretory ducts and bloodvessels: the dartos exists in the scrotum before the descent of the testes, and cannot therefore be derived from the expansion of the gubernaculum testis, as some have supposed.

Beneath the dartos is the *superficial fascia* of the scrotum, continued from that of the abdomen around each separate cord, testicle, and epididymis, thin, loose, and reticular, it becomes continuous with the fascia of the perinæum; as it envelopes the cord and testis on each side, it assists the dartos in forming the *septum scroti*, and retaining each testicle at its own side; it is very distinct above towards each inguinal ring, also posteriorly where it enters the perinæum, but in the intermediate space it is a mere cellular connection between the dartos and the next covering of the testis. Some anatomists, therefore, include this tissue in their account of the dartos, and do not consider it as a separate lamina of the scrotum.

The *tunica communis*, or *erythroides*, or *musculosa*, is a compound tissue; it commences in the inguinal channel, is composed essentially of the cremaster muscle, very variable in strength and color, consisting superiorly of two or three fasciculi, which descend on the outer and forepart of the cord, expand and separate on the testis in curved or arched lines, concave upwards, and inserted partly into the tunica vaginalis, and partly by re-ascending fibres into the cord and pubis (see page 173); the fasciculi are covered and bound to-

gether by a fascia derived from the deep aponeurosis of the abdominal muscles and from the pillars of the external ring (intercolumnar or spermatic fascia); internally they are also connected by a fine membrane derived from the edges of the internal ring (the infundibuliform fascia from the transversalis), and from the cellular tissue in the canal; the two former components of the tunica communis expand all round the testis, but the latter being closely attached to the vessels of the cord adheres to its upper and back part and to the epididymis, and does not, therefore, properly cover the gland: this tunic is the chief means of suspension of the testis, while the cremaster also draws it upwards and outwards, supports and compresses its vascular texture, and urges its secretion through the vas deferens: in old hernia and hydrocele it sometimes acquires prodigious strength and thickness; the influence of these diseases upon this structure, however, is very variable.

The *tunica vaginalis*, or *serosa*, was originally, that is, in fœtal life, a process of the peritoneum, having been prolonged in front of and around the cord and testis, as the latter was descending from the abdomen to the scrotum; at this age the tunica vaginalis freely communicated with the cavity of the peritoneum by a canal which led along the forepart of the cord from the abdomen to the scrotum: this canal, however, previous to birth, was closed by the adhesive process, and ever afterwards the cavity of the tunica vaginalis is distinct from that of the peritoneum.* The tunica vaginalis, therefore, is a serous membrane, a shut sac of an oval form, suspending and partly inclosing the testicle, and also reflected over its anterior part and sides, and larger than the gland, as it also incloses a portion of the epididymis and of the cord; that portion of it which suspends the gland, and which lines the scrotum, may be named the tunica vaginalis *scroti*, or parietal layer, while the reflected portion, which covers the sides and forepart of the testicle, is the tunica vaginalis *testis*, or visceral layer. This membrane is so loosely connected to the scrotum that it can be detached from it with little force; it is thence reflected on the sides and forepart of the epididymis and testis; it also ascends a short distance on the forepart of the cord, higher upon its inner side, and separated from the epididymis by the vas deferens and the spermatic vessels; the posterior part of the epididymis is altogether uncovered by it; as it is continued from the epididymis to the testicle it passes in between these organs on their outer side, so as to form a sort of pouch or *cul de sac* between them. Both the testicle and epididymis are in reality behind this serous membrane, and nothing is contained within its cavity except the serous fluid which lubricates its opposed surfaces, and which facilitates that gliding motion which the testicle undergoes in the scrotum; hence in hydrocele, or dropsy of this sac, the testis is almost always at the upper, inner, and back part of the tumor. When the anterior part of the tunica vaginalis is divided, we see its internal surface smooth and polished; shining through its reflected layer which covers the testis, we can discern the next, or the fibrous tunic of the gland, to which it adheres very intimately, forming with it a true fibro-serous membrane like the pericardium or the dura mater: the tunica vaginalis serves to insulate the testis from adjacent parts, and to facilitate those gliding motions which enable it to elude injury or pressure.

Tunica albuginea is a dense fibrous membrane, of a bluish white color; the proper capsule of the gland, adheres to it, preserves its form, and sends several processes or septa into it, which will be seen when it has been divided; it has no connection to the epididymis; the reflected layer of the tunica vaginalis is intimately united to it; through it the bloodvessels of the vascular coat can be distinctly seen; having invested the whole gland, it is

* When this canal is not thus closed, a hernia usually occurs, which is named "congenital inguinal hernia." In most animals it communicates with the general peritoneum at all ages.

inflected into it posteriorly in the form of a vertical plate or partition, composed of two laminæ, one from either side, inclosing between them the vessels, nerves, and ducts; this is the *corpus Highmorianum* or *mediastinum testis;* from its anterior or visceral border numerous bands radiate forwards, inwards, and outwards, and adhere to similar processes from the inner surface of this coat; these are the *septa* or *desipimenta testis,* which divide the organ into so many compartments, conduct the vessels to and fro, preserve the form of each, and protect the glandular contents from compression; in the mediastinal process the bloodvessels are most distinct posteriorly, the seminal ducts anteriorly.

Tunica vasculosa, so named by Cooper, is an extremely delicate membrane, and in immediate contact with the glandular tissue, composed of minute but tortuous ramifications of the spermatic vessels, united by a fine cellular web; it lines the albuginea, and is so thin in some places as scarcely to deserve the name of a distinct membrane; it not only envelopes the surface, but also sends in delicate membranous processes along each of the septa, which convey the nutrient vessels to the lobules of the gland.

Fig. 55.*

Each *testicle* is of an oval form, flattened on each side, also a little on the back part beneath the epididymis; it is suspended rather obliquely, the superior extremity being directed forwards and outwards, the inferior backwards and inwards; the left is a little lower than the right; hence, when the thighs are crossed, these glands do not approximate so closely, thereby they escape compression; bent like an arch, along the posterior surface and external aspect of each, is the *epididymis,* long and narrow, large above (globus major), narrow in the middle (body), and again enlarged below (globus minor), attached to the testis above by vessels, and in the rest of its extent by the reflected layer of the tunica vaginalis, closely on the internal, but very loosely on the external or femoral side; from its inferior extremity the vas deferens proceeds, and thence ascends along its internal side. Divide the tunica albuginea anteriorly, and we observe the testicle to be composed of a soft, grayish, or yellowish pulpy substance, which, when opened out a little and floated in water, is found to consist of numerous fine, tortuous shreds or vessels of delicate texture, loosely connected to each other; some are of considerable length, and with a little care may be drawn out of the gland to the extent of two or three feet, presenting at first a knotted or beaded appearance, owing to the coils or convolutions; they are placed in packets or fasciculi, which are separated from each other by fibrous bands or septa, derived from the tunica albuginea, and which may now be seen to pass in considerable number through the gland towards the back part to join the *corpus Highmorianum,* which is broader above than below, and perforated in the former situation by the excretory ducts. These packets or bundles of tubes are the *lobules* of the testis, between three and four hundred in number; each is of a flattened, conical form, the base towards the surface, the apex posteriorly towards the mediastinum, inclosed in two membranous capsules, one from the tunica albuginea,

* A section of the testicle. 1. The cavity of the tunica vaginalis; the external layer is the tunica vaginalis scroti, and the internal, which covers the testicle, is the tunica vaginalis testis. 2. The tunica albuginea. 3. The tunica vasculosa, or pia mater testis. 4. The corpus Highmorianum, or mediastinum testis, showing the rete testis between its laminæ and the fibrous septa which connect it to the internal surface of the tunica albuginea. 5. 5. The convolutions of the tubuli seminiferi, terminating in the tubuli recti. 6. The epididymis.

the other from the tunica vasculosa, and composed either of one or of a mass of *convoluted tubuli seminiferi*, with minute bloodvessels; some tubes appear larger than others; their average diameter is the $\frac{1}{150}$ part of an inch, and occasionally they receive injection from mercury, but seldom admit any fine-colored fluid; in each lobule these tubes commence or terminate either in anastomosing loops or in free cæcal ends; their convolutions also appear to communicate; but the tubuli in one lobule do not directly inosculate with those in another, hence mercurial injections are often but partially successful, some of the lobules only being filled; the tubes are less convoluted posteriorly, where several coalesce, and they all terminate in about twenty larger and less convoluted vessels, which proceed in parallel lines towards the back part of the gland; these are the *tubuli recti;* they enter the mediastinum, and if one lamina of this process be raised off, they will be seen entangled with each other, and with the vessels and nerves of the gland; this latter structure is named *Rete Testis,* is placed near the posterior part of the gland, between the laminæ of the mediastinum; from the upper part of it about eight or ten tortuous vessels ascend obliquely backwards, pierce the tunica albuginea, and arrive at the head of the epididymis; here they increase in size, and become coiled or convoluted; these are the *vasa efferentia*, or *coni vasculosi:* they form the head or globus major of the epididymis, and unite into one small duct (the vas deferens), which is twisted and coiled over and over again in a most extraordinary and peculiar manner. The body and globus minor are solely composed of this convoluted vessel, which by care may be unravelled to a great extent; some coni vasculosi, or coiled seminal ducts, continue from the head through the body of the epididymis, and end in the vas deferens; the convolutions of this latter, of which the epididymis thus principally consists, are connected to each other by fine cellular tissue, and by the reflected tunica vaginalis; it has no fibrous capsule like the testis; from its lower extremity the *vas deferens* at length escapes, and, increasing in size and density, this duct bends upwards along the inner side of the epididymis; a little above the head of the latter it becomes a part of the spermatic cord, and is connected to the spermatic vessels and cremaster muscle behind, and distinct from both; with these it continues its course obliquely upwards and outwards along the inguinal channel, and through the internal abdominal ring; it here separates from the spermatic vessels, the latter ascending towards the spine, and passes backwards, inwards, and downwards, inclosed in the lateral fold of peritoneum, which conducts it to the bladder, along the side and inferior fundus of which it runs internal to the vesicula seminalis, and converging to its fellow: at the base of the prostate gland each vas deferens joins obliquely the duct of the corresponding vesicula, the union of which forms the *ductus ejaculatorius communis*, which runs through the prostate obliquely forwards and inwards, and opens into the prostatic portion of the urethra on the side of the verumontanum. While the vas deferens is contained in the spermatic cord, it lies posterior to the spermatic arteries and veins, and to the cremaster muscle; as it passes through the internal ring it hooks round the outer side of the epigastric artery, being separated from it by the spermatic artery alone; it next passes over the psoas and iliac muscles, the external iliac artery and vein; it then bends over the obliterated hypogastric artery and descends internal to it; and in the same manner it next crosses over the ureter, so as to lie at first anterior to that tube, or between it and the bladder, and then to descend along its internal side; it then runs between the bladder and rectum, near to its fellow, and internal to the vesicula seminalis, as far as the prostate gland, which it perforates in the direction before mentioned. This vessel has a peculiar, hard, wiry feel, like whipcord; its calibre is very small; its coats are two in number, an internal mucous, and an external very thick, firm, and white, like fibro-cartilage; the

mucous surface is pale, rough, and alveolar, but very thin; the external coat is most probably fibrous, the fibres being principally circular; their true character is not ascertained in man, but in some animals the fibres are longitudinal and circular, and apparently muscular. Between the vesiculæ each vas deferens is flattened, enlarged, and often convoluted; when it enters the prostate it again contracts, and its firm external tunic ceases. In some a second duct, *vasculum aberrans*, will be found to leave the testis or the epididymis, and to run for some distance parallel to the vas deferens, which in some cases it will join, while in others it will be found to end in a *cul de sac.*

The *spermatic cord* extends from the epididymis to the internal abdominal ring; it consists of the vas deferens, spermatic artery, veins, nerves, and lymphatics; this fasciculus of vessels is covered by loose cellular membrane, and by the cremaster muscle: beneath the latter and the fascia which supports it, the vessels of the cord will be found joined together by a fine membrane, named the *tunica vaginalis of the cord;* this is the remains of that portion of peritoneum which in the fœtus accompanied the spermatic vessels to the scrotum, and which after birth lost its serous characters, and became converted into condensed cellular membrane; this covering is strengthened by the prolongation of the fascia transversalis which is continued from the internal abdominal ring along the spermatic vessels. The *spermatic artery* arises from the abdominal aorta below the renal artery, and not unfrequently from the latter; it descends along the psoas muscle, passes through the internal abdominal ring on the outer side of the epigastric artery; it then enters the spermatic cord, is conducted to the back part of the testicle, and divides into several branches which enter the rete testis; these subdivide minutely as they proceed into the substance of the testicle, in which they twine around the tubuli seminiferi and the spermatic veins; one or two small arteries from the epigastric are distributed to the cremaster. The *veins*, when they leave the rete testis, twine around the arteries, and then ascend in the spermatic cord; a little above the testicle these vessels become very tortuous, and form a plexus, which is named Corpus Pampiniforme; the spermatic veins then accompany the spermatic artery through the inguinal canal and along the psoas muscle towards the spine: the right spermatic vein generally ends in the inferior cava near the entrance of the right renal vein; the left frequently ends in the left renal vein. The nerves of the testicle are derived chiefly from the spermatic plexus, which is formed by the union of branches from the lumbar ganglions of the sympathetic, with filaments from the splanchnic nerves and from the renal plexus; the cremaster muscle is also supplied by branches from the lumbar plexus of spinal nerves, hence this muscle is, to a certain extent, voluntary.

The *vesiculæ seminales* are two membranous sacs of variable size, situated on the inferior surface of the bladder, behind and above the prostate gland, on the outer side of the vasa deferentia, and anterior to the rectum, converging before, diverging behind, connected to the bladder by filamentous tissue, surrounded by venous plexus, and forming the sides of the triangular space, which is completed by the prostate gland, and by the recto-vesical fold of peritoneum; each is of an oval figure, about two inches long and half an inch broad; the superior and posterior extremity is large and round, and in contact with the ureter; the anterior is narrow, connected to the prostate gland, and ends in a small duct which joins the vas deferens; the union of these forming the *common seminal* or *ejaculatory duct*, which is about three-quarters of an inch long, and passes obliquely forwards and inwards through the prostate gland, between its middle and lateral lobes, and opens into the urethra by the side of the anterior extremity of the verumontanum. Although the vesiculæ look like a congeries of cells, yet by dissection they may be unravelled, so as to appear as one continued tube convoluted or coiled very much, the

different coils communicating with each other; those organs are covered by a dense fascia, which is continued from that covering to the prostate gland. Each vesicula consists of two tunics, viz., mucous membrane internally, and peculiar gray substance externally, somewhat similar to, but softer than the outer coat of the vas deferens. The vas deferens communicates very freely with the corresponding vesicula; hence air or fluid injected into the vas deferens will often distend the vesicula seminalis of the same side before it escapes into the urethra by the common ejaculatory duct. These organs are generally believed to contribute some additional secretion to the seminal fluid, rather than to serve as reservoirs for the latter; their exact use, however, is not well known; they are wanting in many animals. The common seminal or ejaculatory ducts are thin, the external coat of the vesiculæ and of the vasa deferentia cease, and these canals appear to be formed of little more than a fine mucous membrane; their calibre is larger and more dilatable than those of the vesiculæ or testis.

The *prostate gland* is situated at the anterior and inferior part of the pelvis, behind the triangular ligament, and in front of the rectum, to which it is connected by cellular membrane; it surrounds the neck of the bladder and about an inch and a quarter of the urethra; is attached and nearly fixed in its position by the anterior ligaments of the bladder to the lower edge of the symphysis pubis, from which it is about three-fourths of an inch distant, also by the posterior lamina of the triangular ligament, which incloses the membranous part of the urethra, and expands around this gland; it is also surrounded by several veins. The prostate is somewhat chestnut or heart-shaped, or triangular; the base is posterior, and connected to the vesiculæ seminales; the apex is anterior, and extends to within a short distance of the triangular ligament; in the erect posture its long axis is nearly horizontal, sloping a little downwards and forwards, but in the recumbent it is the reverse, the base being on a lower level than the apex: only a small portion of it lies superior to the neck of the bladder and urethra; this part is convex, and is covered by the dorsal veins of the penis, and by the anterior ligaments of the bladder; the inferior or posterior surface is almost flat, a slight groove is generally observable on it, extending along the mesial line; this surface is attached to the forepart of the rectum, and may be felt distinctly either in the living or in the dead subject by the finger introduced into the intestine about two inches and a half above the anus; the sides of the gland are smooth, very round, and covered by a strong fascia, by several veins, and by the levatores ani muscles; the relation of the urethra to the prostate varies, in general it is one-third nearer to its upper than its lower surface; in some the gland is absent above, and the urethra may be said to groove it only; in others it forms a cylinder around the canal, wider in the centre than at the ends; and in some rare cases it has been found thicker above the urethra, being separated from the rectum only by a thin lamina. In the base or posterior end is a notch for the entrance of the common ejaculatory ducts; this notch, together with the groove on the posterior surface, and the passage of the urethra above this, have caused it to be described as consisting of two lateral portions, called the *right and left lateral lobes;* these are connected to each other posteriorly by a small transverse process called the *middle lobe;* the latter may be seen by detaching the vesiculæ and vas deferentia from the bladder, and leaving them suspended by their common ducts, the middle lobe of the prostate will then be seen to pass from one lateral lobe to the other, and to be closely connected to the mucous membrane of the bladder, and above the ducts: the bilobed appearance of this gland is more distinct in animals than in man.

The prostate has a firm, resisting feel, a grayish color, and a very compact structure; these characters, however, chiefly depend on the strong fascia which invests it, and which forms its capsule: the capsule has been already

described as being partly derived from the posterior layer of the triangular ligament, which expands on the sides and inferior surface of the gland, and partly from the reflection of the pelvic fascia from the pubes, called the anterior ligaments of the bladder. Next continue the incision, which was made in the forepart of the bladder, through the upper part of the prostate, so as to lay open the urethra; we shall perceive how this gland surrounds the canal, also the greater thickness of its lateral portions. The prostate gland consists of several follicles or acini closely connected to each other, and covered externally by the capsule, and internally by the mucous membrane; a reddish, filamentous tissue also pervades it, which appears of a fleshy nature, and continuous with the muscular fibres of the bladder; these follicles open by several small ducts, ten or twelve on the lower surface of the urethra, in two lateral depressions, called prostatic sinuses, on either side of the verumontanum; some small ducts also open on the upper surface of the canal; a white, brownish, viscid fluid can be squeezed from these small openings; the contraction of the bladder and of its sphincter, with that of the levatores ani muscles, no doubt express this fluid from the gland to lubricate the urethral canal. The prostate is absent in the female, and small and tender in the male, previous to puberty.

The *Penis* is situated in front, and connected to the symphysis pubis; is divided into its root or roots, body, and extremity or glans; the two latter are covered by the integuments and partly by superficial fascia; the skin, thin and loose, is continued from the abdomen and scrotum around this organ, and extends some way beyond it in the form of a loose sheath, the *prepuce*, from the extremity of which it is inflected as far as the corona glandis, where it becomes very thin; is thence continued over the glans to the orifice of the urethra, and is continuous with its lining membrane; inferior to this opening it forms a triangular fold, the frænum preputii; the sides of the prepuce are connected together by a very loose reticular tissue, and this fold is expanded and obliterated when drawn back, or when the penis becomes distended; the inner side of the prepuce is like mucous membrane, and of more delicate texture than the external, and that portion of it which is continued over the glans is still more delicate than either. Beneath the skin, around the corona glandis, are a number of small sebaceous glands, glandulæ odoriferæ, or Tysoni; the subcutaneous tissue, both of the prepuce and penis, is very loose, is continuous with and similar to the dartos; it is never the seat of adipose deposit, but is liable to serous infiltration; the orifice of the prepuce is sometimes, particularly in young persons, so contracted that the skin cannot be retracted so as to allow the escape or protrusion of the glans; this is termed "phymosis," and, if in this condition the skin be forcibly drawn back over the base of the glans, it sometimes cannot be returned, but forms a tense constriction or strangulation round the latter; this is termed "paraphymosis." The superficial fascia which covers the penis is continued from that of the abdomen, and extends around the penis as far as the corona glandis: it is thick and strong posteriorly, where it is reflected from the linea alba on the penis, so as to form the superficial suspensory ligament of the latter; it often contains some yellow, elastic tissue; anteriorly it is loose and delicate.

The *crura*, or *corpora cavernosa penis*, are two long, semi-cylindrical bodies, composed of a strong, elastic, tendinous, and fibrous substance, forming a sort of tube, filled with a soft cellular or *erectile tissue*, through which a large artery and many small tortuous veins, with free cellular inosculations, run from one end to the other. Each crus commences narrow in front of the tuber ischii, and adheres most intimately to the rami of the ischium and pubis, as far forwards as the symphysis; anterior to this the two crura become inseparably united, and continue so as far as the corona glandis, forming the body of the penis; here they end in one obtuse point, over which the glans penis,

which is the expanded extremity of the corpus spongiosum urethræ, is folded, but with which it has little or no vascular communication: the crura are attached to the symphysis by the *true suspensory ligament*, which is very strong, of a triangular figure, yellow, and elastic; it arises from the symphysis, and is inserted into each crus; it consists of two laminæ, between which the dorsal vessels and nerves of the penis pass. The crura are separated from each other by an imperfect tendinous septum, composed of parallel fibres, with such intervals between them that the cavity of one crus communicates with and can be injected from that of the other; this septum is named *pectiniforme;* it is more perfect behind, but so deficient in front that the two crura may be regarded as one; a number of fibrous cords (*trabeculæ,*) also cross the interior of each; these chiefly arise from the inferior surface, and thence radiate in different directions, and are inserted into the inside of each sheath; both these and the septum must impart considerable strength to the organ, and limit its distension. The crura penis are somewhat conical, the apex of each being attached to the ischium and pubis, the base supporting the glans; they are round externally, flattened towards each other; a wide and deep groove exists between them inferiorly, which contains the urethra and its corpus spongiosum, and a more superficial one superiorly, in which the dorsal vessels and nerves of the penis run. The erection of the penis during life is caused by a greater quantity of blood than usually circulates through this organ, being propelled by an increased action of the arteries into the small vessels of the corpora cavernosa penis, induced by a peculiar excitement of the nervous energy. Anatomists are not agreed as to the exact structure of the corpora cavernosa, or as to the proximate cause of their erection during life, or how the blood is circumstanced during that condition: some consider that the arteries pour their blood into the cells of the cellular tissue which surrounds them, so as to cause their distension, and that from these the blood is slowly and gradually absorbed by the veins; others conceive that the arteries directly communicate with the veins, and that these latter vessels are tortuous and coiled to such a degree, their coils communicating by lateral openings, as to form the plexuses which serve to retard the course and delay the return of the blood, and so cause the distension and consequent erection of the whole organ. The contraction of the dartos, and of the special muscles alluded to (at page 261), have been also supposed to contribute to this condition. The penis is supplied with blood from the terminal branches of the pudic artery; opposite the ramus of the ischium arises the artery of the bulb, inclosed in the triangular ligament; it ramifies in the corpus spongiosum urethra as far as the glans; the pudic then ends in the arteriœ dorsalis penis and cavernosa; the dorsal passes between the crura and the arch of the pubis, and between the laminæ of the suspensory ligament; it then runs tortuously forwards near the median line, ends in several preputial branches, and in some deeper ones, which form a free circular inosculation around the corona glandis, and also communicate with branches in the glans and corpus spongiosum urethræ. The arteria cavernosa enters the crus near its origin, and proceeds tortuously through it, near the septum, giving off numerous small branches in its course; these are entwined among the ramifications of the venous plexus, with which they communicate freely. Muller has described small vessels, "arteriæ helecinæ," as arising from this artery, and projecting in tufts from each side of it into the venous cells: this opinion has not been confirmed by subsequent observation. The veins of the penis are large and numerous, and supplied with valves; they are deep and superficial, the former accompany the branches and the trunk of the pudic artery, and join the internal iliac; the superficial commence in the prepuce, pass backwards, receiving branches from its sides and inferior surface, and form the two dorsal veins of the penis; these pass beneath the arch of the

pubis through fibrous canals connected to the sub-pubic ligament: these canals, like the sinuses of the dura mater, serve to keep the veins open and free from pressure; they open into the prostatic and vesical plexuses. The nerves of the penis are derived from the sympathetic and pudic branches of the spinal. Each of these strong fibrous cylinders is filled with an areolar or cellulo-vascular tissue, which is strengthened by the trabeculæ, and which itself is chiefly composed of an interlacement of veins: the cells communicate freely with each other and with the veins. There appears to be in erectile tissue a gradation of structure between true veins and venous plexus; thus at first we find the veins communicating, as it were, by lateral perforations; these become more numerous, distinct vessels disappear, and a mass of communicating cells alone can be detected; these cells appear formed of the prolonged lining membrane of the veins; the interstices of this plexus are filled with a peculiar fibrous texture, of a reddish appearance, and bearing some resemblance to muscular tissue.

The *Urethra* is a membranous canal, about nine inches long, extending from the neck of the bladder to the extremity of the penis, formed of mucous membrane, covered by an elastic coat; the former is continuous posteriorly with that of the bladder, anteriorly with the thin integument of the glans, and in different situations with the lining membrane of the ducts that open on its surface, namely, the prostatic, ejaculatory, Cowper's, and numerous lacunæ. The elastic coat differs in strength in different situations, and is covered at first by the prostate gland; this portion of the canal is called the *prostatic portion* of the urethra; next by the compressores urethræ muscles, the triangular ligament, and a peculiar reddish, spongy, or erectile tissue, which contains several small bloodvessels, chiefly veins; this is called the *membranous portion;* it is separated from the sub-pubic ligament by some considerable veins, and from the rectum by the small triangular space, recto-bulbar, already described. The remainder of the canal is covered by a cellulo-vascular substance of a dark red or purple color, named corpus spongiosum urethræ, which commences in the bulb, and ends in the glans penis; this portion is named the *spongy portion.* The course or direction of the urethra should be first attended to; from the neck of the bladder it passes downwards and forwards; having arrived opposite the symphysis pubis, it describes a very slight curve, concave upwards; it then rises on a higher level than the bulb in front of the pubes, and enters the groove on the lower surface of the corpora cavernosa penis; the remainder of its course depends on the state of the penis; if the latter be collapsed, it forms a marked curve, concave downwards, but this can be changed into nearly a straight line by elongating the penis, and during the erection of the organ it becomes concave upwards, so that in this condition of the penis the whole canal forms but one curve in that direction, but in the collapsed state it forms two curves, somewhat like the letter S, with the posterior curve less sharp or acute. The first, or the prostatic portion, is within the pelvis, about an inch and a quarter or an inch and a half in length; in the erect position of the body its direction is downwards and forwards, is nearer to the upper than to the lower surface of the gland. The membranous portion is about half or three-quarters of an inch long, and is the narrowest part of the canal except the anterior orifice; it is described in general as being concave towards the pubes: it is, however, but very slightly so; it is nearly horizontal, about three-quarters of an inch below the symphysis pubes; it is surrounded by an elastic and erectile tissue, also by the deep lamina of the triangular ligament, and by the compressores urethræ muscles. The spongy portion commences in the bulb in front of the triangular ligament, extends to the extremity of the canal, and ends in the glans penis. The *corpus spongiosum urethræ* consists of a fine erectile tissue, through which an artery from each side (a branch from the internal pudic)

extends; these vessels send off numerous branches, which pour their blood into the surrounding venous cells; the bulb and the glans are expansions of this texture, the former on the inferior, the latter on the superior part and sides; it is invested by a fine but strong and semi-transparent aponeurosis, very different from that which covers the corpora cavernosa; it surrounds the urethra, but is thicker inferiorly and laterally than superiorly. The *bulb* occupies the space between the crura penis, is opposite the arch of the pubis, in front of the rectum and below the level of the membranous portion of the urethra, and about an inch distant from the anus; it terminates gradually in front, in the corpus spongiosum; it is embraced by the acceleratores urinæ muscles, and immediately covered and supported by the anterior or inferior lamina of the triangular ligament; on each side, and rather posteriorly, are the glands of Cowper, between the laminæ of the triangular ligament, and immediately beneath the arteries of the bulb; the bulb is very small in the child. The *glans* is the anterior conical enlargement of the penis, of the same structure as the bulb, only more dense; its base projects beyond the crura superiorly and laterally, and forms the corona glandis, and is cut off obliquely, so that its upper surface is twice as long as its lower; the prepuce is connected to it inferiorly by the frænum. There is no direct communication between the corpus spongiosum urethræ and the corpora cavernosa penis; the one can, therefore, be distended with air or injection without the other, or both may be injected with different colored fluids. In order to inject the crura penis, make a small opening in each crus near its attachment to the ischium, insert a pipe into one of these, and force warm water through it; this will soon escape through the opening in the opposite crus, carrying along with it the blood which was contained in the cells; then secure with a ligature the opposite crus, and inject some colored fluid. To prepare the corpus spongiosum urethræ, make a small opening in the substance of the bulb; next open the dorsal vein of the penis; in it secure a small pipe; water injected through this will escape at the opening in the bulb; when all the blood shall have been thus washed out, the latter opening may be secured, and some colored fluid injected along the dorsal vein; if, however, a fine injection be forced from the pudic, or from the internal iliac artery, it will occasionally succeed in distending the corpora cavernosa penis and the corpus spongiosum urethræ at one and the same time. The student may now detach the crura penis and the neck of the bladder from the pubes, and remove these organs, together with the urethra, from the subject; continue an incision from the anterior part of the bladder through the upper part of the prostate gland, and of the urethra to its extremity; the mucous lining of the urethra will be thus exposed; the difference in the diameter and other peculiarities in different parts of it may now also be observed. 1st. The prostatic portion is somewhat contracted at either extremity, and dilated in the centre, particularly on the lower surface, and at either side of the middle line. These enlargements are called the *prostatic sinuses;* they are separated from each other by a prominent fold of the lining membrane, extending from the uvula of the bladder, along the mesial line of the urethra, as far as the bulb. This fold is named *verumontanum,* or caput gallinaginis: in the centre of it is a very large lacuna (*sinus pocularis*), the orifice of which is directed forwards; on either side of this pouch, and in general external to it, is the opening of the common ejaculatory duct, external to which, and in the prostatic sinus on each side, are the several small orifices of the ducts of the prostate gland. In the closed state of the urethra, the uvula and verumontanum are pressed against the upper part of the canal, and the whole ring is closed by the sphincter vesicæ, but when the bladder contracts, this ring is expanded by the longitudinal fibres, and the verumontanum is depressed by some of the posterior fibres which are inserted beneath it; the prostatic portion of the

urethra is then considerably dilated. The opening of the sinus pocularis, usually not larger than a pin's head, is sometimes much more so, and may admit and obstruct a bougie or catheter in its course to the bladder. 2nd. The membranous portion is shorter, and of a smaller calibre, than the prostatic; it is cylindrical; its anterior extremity is the narrowest portion of the canal. 3rd. The spongy portion of the urethra is much dilated at first, particularly inferiorly (*sinus of the bulb*); anterior to this the small ducts of the anti-prostatic glands open. The canal contracts a little beyond the bulb, and continues of nearly the same diameter until it arrives opposite the scrotum; it is there slightly contracted for a short distance: about an inch posterior to the external orifice of the urethra the canal is dilated in the transverse direction; this dilatation is called the *fossa navicularis*. Lastly, the orifice of the urethra is contracted into a narrow vertical slit. Several small lacunæ open on the surface of the mucous membrane of the urethra, between the bulb and the anterior extremity; they are said by some to be most numerous on the upper surface; they are very variable in number and size; the orifices of these, in a healthy condition of the membrane, are very small; they are all directed forwards. If bristles be introduced into some of these ducts, they will be found in many cases to extend backwards for near an inch in the submucous tissue: these lacunæ secrete a thin mucous fluid, which is expelled by the urine in its passage along the urethra. In chronic diseases of the urethra, these ducts not unfrequently become so much enlarged as to admit the end of a small bougie, and so lead to the formation of a false passage: the largest lacunæ are on the upper surface of the urethra; one in particular, near the fossa navicularis, is named the *lacuna magna*.* This membrane is very extensible as well as dilatable, hence neither its length nor its diameter can be accurately stated; it presents many longitudinal folds which admit of distension; through it appear irregular longitudinal fibres, probably elastic, but by some supposed to be muscular: there is no regular arrangement of circular fibres. The epidermic character of this membrane is most distinct in its anterior portion. If the urethra be distended with spirit, and the crura penis and corpus spongiosum carefully dissected off, a beautiful preparation of this semi-transparent canal may be obtained.

The testicle is the seat of many *morbid* appearances, both in its tunics and in its substance; hydrocele is very common: this is a dropsy in the serous cavity of the tunica vaginalis; this latter membrane may be inflamed, and the adhesive process may obliterate its cavity. The tunica albuginea is sometimes the seat of a firm fungus, which protrudes through the other coverings to the surface. The testicle and epididymis may be the seat of acute inflammation or orchitis, as in hernia humoralis, the effect of gonorrhœa, also of chronic inflammation, with indolent enlargement, or sarcocele. The testis is also the frequent seat of strumous inflammation and suppuration, of fungoid disease in which there is great enlargement, total change of structure, and conversion into cerebriform matter; of true scirrhus and cancer, of hydatid

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* During the dissection of the pelvic viscera, perinæum, &c., the student should frequently practise the introduction of a catheter into the bladder, which is to be done in the following manner: the subject lying on its back with the legs drawn up, the penis should be held by placing the thumb and index-finger on each side of the corona glandis by which means the orifice of the urethra will not be compressed; the penis is then to be drawn upwards, and the catheter, being previously oiled, is next to be introduced in a line with the linea alba into the urethra, directly downwards as far as the bulb; the concavity of the instrument being towards the abdomen. The catheter having reached the bulb, its handle is to be depressed by bringing it forwards between the thighs, and in proportion as this is done the point is elevated, and the catheter glides into the bladder; in this latter part of the operation, the penis must be allowed to sink down, for if it be kept extended on the instrument the membranous part of the urethra will be drawn towards the pubes, by which means the introduction of the instrument wlll be rendered difficult.

tumors, &c.: these glands are also sometimes atrophied. The spermatic cord is sometimes the seat of encysted hydrocele, of varicocele, particularly on the left side, as also of different tumors.

The prostate gland is seldom found *diseased*, except in old men; it is rarely inflamed; an abscess, however, has been met with (unaccompanied by any thickening) in its substance, arising from common inflammation. *Scirrhus.*—The most common disease of the prostate gland is scirrhus; the gland in its natural state is known to be about the size of a chestnut, but when affected with scirrhus, it is often enlarged to the size of the fist. The common appearances observed in scirrhus in other parts of the body can be plainly seen in this gland; when cut into, it appears to consist of a very solid, whitish, or brown substance, with membranous septa running through it in various directions. According to the degree of enlargement that takes place, the urine is passed from the bladder, or the catheter can be introduced to draw it off, with greater or less difficulty. *Calculi* have been found lodged in the ducts of the prostate gland; they are usually small granules of a dark color, and give it a mottled appearance when cut into.

The vesiculæ seminales are seldom found *diseased*; in cases of scrofulous disease of the testicle they have been found similarly affected and filled with cheesy fluid. The urethra is the frequent seat of inflammation, which, when recent, produces suppuration without ulceration, and, if long continued, causes a thickening of the submucous tissue, and thus renders the canal narrow and irregular, and so commences the foundation of stricture. Chancres have been found in it even so far back as the membranous portion, and at the orifice (generally at the lower side) they are by no means uncommon; a chancre in this situation being, according to M. Ricord, the real cause of the peculiar characters of gonorrhœa virulenta. The coverings of the penis are the frequent seat of ulceration, also those of the glans penis; the latter in old persons are very often attacked with warty, cancerous ulceration.

CHAPTER VII.

DISSECTION OF THE FEMALE ORGANS OF GENERATION.

The generative organs in the female are more distinct from the urinary than in the male; they may be divided into the external and internal: the *external parts* are the mons veneris, vulva, labia, clitoris, nymphæ, vagina, and perinæum.

The *mons veneris* is an eminence placed on the upper and anterior part of the pubes; it consists of a quantity of adipose substance beneath the integuments, which in the adult are covered with hair. The *vulva* is the fissure, or common urino-sexual opening between the labia, extending from the mons veneris to within an inch of the anus. The anterior *perinæum* is the small space in front of the anus. The posterior *perinæum* is between the anus and the os coccygis. The *labia externa* or *majora* are the prominent folds of integument which extend from the mons veneris, one on each side of the vulva, thicker before than behind, and are united inferiorly in a crescentic edge, called the commissure or fourchette, between which and the vagina is a small depression, called fossa navicularis; the labia are composed of fat and loose areolar tissue, with numerous sebaceous glands and hair bulbs, vessels, and nerves; beneath the skin and mucous surface is a dartoid texture like that in the scrotum; they are liable to serous infiltration; during parturition they

are unfolded, and admit of the expansion of the vulva; in the infant they are less developed than the following. The *nymphæ*, or labia minora, descend one on each side of the vagina, from the prepuce of the clitoris, and are gradually lost about the centre of the vulva, on the sides of the vaginal opening; they are folds of mucous membrane inclosing an erectile tissue, and are covered by a fine epithelium, and have numerous and distinct sebaceous follicles; they are narrow behind, broad before, and bifurcate at the clitoris; the lower division joins the glans clitoridis, the upper unites with that from the opposite in a hood-like fold, called the prepuce of the clitoris; variable as to size; in some very small, in others very large and prominent, and in some nations hypertrophied and elongated to an extreme degree; in the infant they are more developed in proportion than the labia, and usually project beyond them. The *clitoris* is in the median line, about half an inch below the superior angle or commissure of the labia: it is a small red projection immediately beneath the symphysis pubis and above the vagina; attached by two crura to the rami of the ischii and pubes; these unite and form the body of the clitoris, opposite the symphysis, to which it is connected by a suspensory ligament; it then passes forwards, like a ridge, between the labia from their anterior commissure to its extremity, a little curved, convex upwards, concave downwards and backwards, and terminates in a round, red swelling or tubercle, which from a resemblance to the glans penis, is named glans clitoridis, and is covered by the thin, loose fold of the integument or mucous membrane, called the prepuce, derived from the upper division of the nymphæ. The crura clitoridis are composed internally of a spongy cellular texture, not very unlike the corpora cavernosa, or the corpus spongiosum urethræ in the male; each crus is invested with an erector or compressor muscle analogous to the erector penis; the urethra is received in the angle between the two crura, and, passing forwards beneath the body, ends behind the glans; the whole organ is erectile, being composed of spongy, erectile tissue inclosed in a fibrous sheath; like the nymphæ, it is large in the infant; in the adult its size is variable; in some it is hypertrophied and elongated to the extent of one, and even two inches.

About half an inch below and a little behind the clitoris, between the nymphæ, and immediately above the projecting edge of the vaginal opening, is the round orifice of the *meatus urinarius;* this opening always appears closed, is surrounded by a projecting fold of mucous membrane, on the sides of which are orifices of small mucous glands analogous to Cowper's glands in the male, although probably the true analogues to these bodies are those two organs to which attention has been recently directed by M. Huguier, in a memoir read before the Academy of Medicine of Paris, and which are named the *vulvo-vaginal glands.* These were first described by G. Bartholinus, and have been noticed by the older writers, but no mention is made of them by modern authors. These glands are seated one at each side of and a little behind the vaginal orifice, in size and appearance like an apricot-stone covered with its epidermis; their excretory ducts, about half an inch long, open near the margin of the hymen at the base of the lateral and posterior caruncles, by which they are usually concealed: like the other parts of the generative apparatus, these become much developed at puberty; they pour out a copious supply of clear, transparent mucus, which M. H. states can, under peculiar excitement, be ejected by the involuntary contraction of the surrounding muscles. These glands and their ducts are very variable as to size, and, like the clitoris and adjacent surface, possess peculiar sensibility; their atrophy and hypertrophy bear a proportion to the condition of the ovaries; hence attention to their condition may assist in the diagnosis of disease: during pregnancy they are diminished, and in old age are atrophied; they are occasionally absent; in structure, and in situation, also in pouring forth their secretion on

the common urino-sexual surface, they have some analogy to Cowper's or the anti-prostatic glands. Immediately behind and a little below, but partly surrounding this opening, and from this descending on each side of the vagina, is an elevation of the latter by an erectile tissue, somewhat analogous to the bulb or spongy portion in the male. The meatus is about an inch and a half in length, leads backwards and upwards in the upper wall of the vagina, to which it adheres almost inseparably, is slightly curved beneath the symphysis pubis, to which, as also to the crura of the clitoris, it is attached by the triangular ligament and pelvic fascia, or rather by the anterior ligaments of the bladder; between its upper surface and the latter is a venous plexus; this canal is composed of mucous membrane continued from the bladder, surrounded by an elastic, erectile, and muscular tissue; this membrane is of a deep red color, and presents longitudinal plicæ, which account for its great dilatability; longitudinal veins appear through it, and several lacunæ open upon it; its elastic and erectile tissue retains it in a closed state; the longitudinal fibres of the bladder can be traced through the cervix into the latter, and probably assist in the expansion of this canal when contracting the reservoir; it perforates the triangular ligament of the urethra in the same manner as the membranous portion does in the male, to which division of the canal in the latter the female urethra is somewhat analogous. The compressores urethræ muscles, both vertical and transverse, are similarly arranged; the vesical opening has no encircling prostate gland; the anterior orifice is a little constricted by a surrounding fibrous band, which resists dilatation as in the male, but it has not the same form.

The orifice of the *vagina* is directly below that of the urethra, is somewhat oval, with a projecting and rather corrugated margin; in the virgin it is partially closed in front by a crescentic fold of membrane, termed the *hymen;* concave forwards, only leaving the anterior superior part of the orifice free; very variable, however, it is sometimes circular, with an opening in the centre; its loose edge is usually fringed; it is sometimes only rudimental, and on the other hand it is sometimes complete, and is then called imperforate hymen, a condition attended with danger, as it confines the menstrual secretion: it is a fold of mucous membrane inclosing some small vessels. After laceration the margin presents an irregular series of reddish, fringe-like processes, named the *carunculæ myrtiformes;* these are variable in number and size. The course and connections of the vagina will be better seen when the pelvis shall have been divided for the purpose of examining the internal organs of generation. Dissect off the integuments and fascia from the perinæum and labia, and the following muscles may be observed: the *sphincter ani, levatores ani, coccygæi,* and *transversales perinæi,* are similar to the muscles of the same name in the male; the middle fibres of the levatores ani are expanded on the sides of the vagina: the *erectores clitoridis* are analogous to the compressores penis; and the *sphincter vaginæ* corresponds to the accelleratores urinæ; it extends from the clitoris superiorly around each side of the vagina to the central point of the perinæum in front of the anus; it may be described as double, each *arising* in common from this point, then, passing forwards as a flat band on the side of the vagina, is *inserted* by a tendinous expansion partly into the side of the clitoris and partly into its upper surface and suspensory ligament, in conjuction with that from the other side; it contracts the orifice of the vagina, which is the narrowest part of the canal.

Make the lateral section of the pelvis in the same manner as was directed in the dissection of the male pelvis (page 268). The peritoneum may be first examined; this will be seen to descend along the forepart of the rectum to within three or four inches of the anus; is thence reflected forwards on the posterior part of the vagina, the superior third of which it covers; ascends on the posterior surface and sides of the uterus; continues round the supe-

Fig. 56.*

rior fundus of this organ to its anterior part, on which it descends as low as the cervix only, and has, therefore, no connection to the vagina in front; it is thence reflected to the bladder, and continued over this organ, as in the male, to the abdominal muscles; thus, in the female pelvis, the peritoneum forms one *cul de sac*, which is deep, between the rectum and vagina, and another between the uterus and bladder, which is shallow. From each side of the uterus a broad fold of peritoneum is extended transversely towards each iliac fossa; these are the *broad ligaments* of the uterus; inclosed superiorly between the laminæ of each are the *Fallopian tube* in the centre, *the round ligament* of the uterus in front, and the *ovarium* with its ligament and vessels behind; the ovary and round ligament raise the membrane into two lesser folds, which, with the Fallopian in the centre, have been named *alæ vespertilionis*. Dissect off the peritoneum from one side of the rectum and vagina, and the pelvic viscera will be more distinctly seen.

The *rectum* takes the same course as in the male, only it is somewhat more curved; it lies behind the uterus and vagina, and united to the latter by a vascular plexus. The *vagina* surrounds the neck of the uterus, is prolonged a little way upon it, and forms a circular depression around it, deeper behind than before; thence it descends obliquely downwards and forwards for about six or seven inches between the rectum, the bladder, and urethra, in the axis of the lower orifice of the pelvis, slightly concave before and convex behind, of a circular form, the anterior and posterior walls flattened and in contact; the uterine end is the largest part, and often much dilated; the inferior orifice or vulva is the smallest; the anterior wall is shorter than the posterior; very dilatable and very elastic, as is seen during and after parturition, closely connected anteriorly to the bladder by reddish filamentous structure, like the dartos, and inseparably to the urethra; posteriorly it is attached to the peritoneum during its upper third; the remainder adheres to the rectum by a loose, dartoid, and venous tissue; the broad peritonæal folds, the reflections of the pelvic fascia, the levatores ani muscles, cellular tissue, and venous plexuses, are connected to its sides; inferiorly the constrictor surrounds it;

* An antero-posterior section of the pelvis of a female giving a lateral view of the viscera *in situ*. 1. The symphysis pubis. 2. The urinary bladder. 3. The urethra. 4. The uterus. 5. The vagina. 6. The labia pudendi. 7. The clitoris. 8. The rectum. 9. The peritoneum reflected over the bladder, uterus, and rectum.

its anterior wall is thicker than the posterior, and the urethral portion is the most so; lined by a vascular mucous membrane, which is transversely rugose. These rugæ are very distinct in the infant, they are not like the ordinary plicæ of mucous membranes, to admit of distension, but firm ridges like those on the palate behind the anterior teeth; they are seen on the upper and lower surfaces, but chiefly on the former, and near the vulva. In the median line, on each surface, is a more prominent ridge or raphe, extending nearly the whole length; these lines are called the columns of the vagina. This membrane is covered with a distinct epithelium of the squamous or cuticular kind; it extends into the uterus, but there becomes of a different nature; it is furnished with numerous follicles and papillæ, especially near the vulva; the mucous membrane is covered by a dense fibrous tissue and by numerous vessels, particularly veins, which form a retiform plexus, or a spongy erectile body, which is covered by a fibrous and dartoid tissue above, and by the sphincter vaginæ muscle below; there is an increase of this spongy tissue at either side of the orifice, between it and the crura of the clitoris. Between the bladder and the vagina the *ureter* may be observed, connected to the upper and lateral part of the latter; its course is longer and more curved in the female pelvis than in the male; its vesical extremity corresponds to the cervix uteri; its entrance into the bladder is nearer the uvula than in the male, and the trigone is of greater transverse, but of less antero-posterior extent. The peculiarities of the female bladder have been already noticed.

The *Uterus* is situated in the pelvis, between the bladder and rectum, connected to both by peritoneum, and fixed thereby in its situation, as also by its broad and round ligaments, and by the vagina; it enjoys, however, a certain degree of mobility; it occupies the median line, but often inclines to one side, especially the left, and is more or less in contact with the convolutions of the small intestines. The uterus is of a flattened pyriform or triangular shape; the larger end or fundus is superior and anterior; the smaller end or cervix inferior and posterior; the intermediate portion is named the body, and is separated from the neck by a constricted line; the vagina surrounds the cervix uteri, and ascends higher posteriorly than anteriorly; about three inches long, one inch thick, and two broad at its fundus, this and the body equal two inches in length and the cervix one; at the lower extremity of the cervix is a small transverse slit, the *os uteri* or *os tincæ;* the long axis of the uterus leads obliquely backwards and downwards in the same line as that of the upper orifice of the pelvis, and forms an angle, concave forwards, with the axis of the vagina, which leads obliquely forwards and downwards in the line of that of the lower orifice. The anterior surface is flattened, and covered by the peritoneum in its upper three-fourths; the lower fourth is connected to the inferior surface of the bladder by cellular tissue; the posterior surface is more convex, and is entirely covered by peritoneum: the sides are slightly concave, and give attachment to the broad, round, and ovarian ligaments, and to the Fallopian tubes. The *broad ligaments* are the two peritonæal folds which extend to the iliac fossæ, and form with this organ a transverse septum in the pelvis, between the bladder and rectum. The *round ligament* arises on each side anterior and inferior to the Fallopian tube, ascends obliquely outwards in the anterior fold of the broad ligament, passes through the internal ring into the inguinal or spermatic canal, accompanied by a close sheath of peritoneum (canal of Nuck), escapes through the external ring, and is lost in the cellular tissue of the mons and labium externum; is composed of muscular and fibrous tissue derived from the uterus, together with small, tortuous arteries, a venous plexus and filaments from the spermatic nervous plexus; these ligaments retain the uterus in the median line, and, when it becomes enlarged, support it anteriorly, and draw it towards the abdominal muscles; the veins in these cords are not unfrequently

in a varicose state; the arteries maintain a communication between those of the uterus and the groin. The *ovarian ligament* is a round, fibro-muscular cord, from an inch and a half to two inches long, arising from the upper and lateral angle of the uterus, below and behind the Fallopian tube, and inserted into the inner end of the ovary. The *Fallopian* tubes extend from the upper angles of the uterus towards each side of the pelvis. The *superior end* or *fundus* is convex, and directed upwards and forwards; it is behind the bladder, and below the level of the pubes. The *lower end,* or *cervix,* presents the os uteri or tincæ at is termination, looks backwards and downwards, is embraced by and projects into the vagina. The *os* is small and circular, and the lips or borders smooth, in the virgin, but in those who have borne children it becomes larger and more transverse, and the edges slightly fissured or wrinkled; it presents two lips, one is anterior or superior, and thicker than the other, which is posterior or inferior, and longer. The parietes of the uterus are nearly a quarter of an inch thick; its cavity, therefore, is very small, the surfaces nearly in contact, mucus only interposed; the area in the body and fundus is somewhat triangular, the base above. The cervical portion is cylindrical and flattened, communicates with the vagina by the os uteri or tincæ, or *ostium externum,* above which the canal through the cervix is narrowed, and leads into the body of the uterus by a very constricted opening, the *ostium internum.* The triangular cavity in the uterus then commences; the apex is in this opening, the base in the fundus, each angle of which is depressed into a funnel-shaped recess, in the botom of each of which is the very minute orifice of the Fallopian tube. The uterus being the organ for the gestation of the embryo during the long period between its conception and the completion of its maturity, and also the principal agent in its final expulsion from the body of the parent, possesses very peculiar organization, and is endowed with peculiar and interesting powers. It is composed of three different tissues or tunics, a serous, a fibrous or fibro-muscular, and a mucous; it is furnished with nerves and vessels, which are small in the quiescent state of the organ, but which become wonderfully developed during uterine gestation; it possesses very little of the areolar, and none of the adipose tissue, except the thin, connecting lamina between its peritonæal and muscular tunics. The first or *serous coat* invests the fundus and body, all the posterior and the three upper fourths of the anterior surface; on each side of the anterior *cul de sac,* between the uterus and bladder, it forms a semilunar fold, named *vesico-uterine ligaments,* and in like manner its reflection from the vagina to the rectum presents, on either side of the posterior *cul de sac,* a semilunar fold, named *recto-uterine ligaments;* it adheres closely to the fundus and surfaces, but loosely to the sides, and, as the organ enlarges, the lateral duplicatures or broad ligaments unfold and expand, and thus materially contribute to a corresponding extension of the serous investment. This coat answers the same *uses* as on other hollow viscera; when the womb is distended, it supports and strengthens its other tissues, it insulates it from surrounding parts, and mutually facilitates its motions and those of the adjacent organs. The *mucous membrane* is in general pale, though sometimes very dark; it is smooth, and furnished with an epithelium, which is columnar and ciliated. In the cervix it presents longitudinal median lines or columns, from which pass off, at nearly right angles, smaller transverse rugæ, like branches of a tree. This appearance, named arbor vitæ uterina, is more perfect in the virgin state: in this region of the uterus in particular are many mucous follicles, the closure and distension of which give rise to a vesicular, and sometimes even a morbid appearance (ovula of Naboth); the membrane is smoother and more vascular in the body than in the cervix; this difference has been well observed in those who have died during the menstrual period; under ordinary circumstances this membrane is very fine and delicate, and so

difficult of demonstration that some have even (but erroneously) denied its existence; it is continuous inferiorly with that of the vagina, and superiorly it extends through the Fallopian tubes and their fimbriated extremities, where it is continuous with the peritoneum on each side, thus presenting the single example of continuity between a mucous and serous membrane.

The *middle* or *muscular coat* is very thick and firm, and resists the knife like cartilage; composed of strong, grayish fibres, closely interwoven and traversed by numerous vessels. The true nature of this structure could not be known if our observations were confined to the unimpregnated human uterus; examination, however, of this organ, when pregnant, aided by the microscope, corroborated by chemical analysis, and elucidated by comparative anatomy, have revealed its true character to be muscular tissue; this, in the quiescent state of the organ, is condensed, and, as it were, atrophied, but, when impregnated, the parietes become wonderfully vascular, the fibres softened and unravelled, the sensibility and nervous energy proportionably exalted, and the muscular structure is then developed in an eminent degree; the muscular fasciculi become evident, and are expanded into extended laminæ, whose fibres interlace in the same manner as those of the involuntary system, or of organic life in general; like the fibres of the latter, also, they want the transverse striæ. Around the cervix they are in circular laminæ, some fibres interlacing or crossing others; on the body and fundus the fasciculi are large, and flat bands disposed in a superficial and deep lamina; the superficial are longitudinal or vertical on the front of the back part, and oblique on the sides and fundus, and at the angles of the latter are continued on the Fallopian tubes and on the round and ovarian ligaments; the deep layer consists of two series of conical fibres, the apices around the Fallopian tubes, the bases intermingling on the body of the uterus. This tunic of the uterus is truly interesting from the very curious changes it can undergo; thus through the greater portion, and often through the entire period of life, it remains inactive, and condensed into a thick, close, and almost solid, whitish, homogeneous mass, without a single feature in common with contractile tissue; with this contrast its plainly muscular appearance in the gravid uterus, when its fibres admit of a passive extension and elongation to an almost unlimited extent, while at the same time they present all the characters of highly developed muscle, except the manifestation of the contractile power, which it refrains from exercising with any vigor until the period of parturition, at which hour it displays this power with extraordinary energy and with wonderful intensity and force. During pregnancy the vascular system also of the uterine parietes is equally developed; the *uterine arteries* which are derived from the internal iliac, and the *spermatic* from the aorta, become enlarged, elongated, and tortuous. The *uterine veins* are still more remarkable; they form large channels (uterine sinuses), like the larger venæ cavæ hepaticæ, through the uterine walls, and appear formed only of the lining membrane which adheres to the surrounding fibrous tissue; these veins form plexuses at each side of the uterus, and open into the internal iliac, the renal, and the cava. The *nerves* of the uterus proceed from the hypogastric plexus, which consists of filaments from the sacral and lumbar and pelvic ganglions of the sympathetic; these nerves accompany the uterine arteries: others are derived from the renal plexus, and accompany the spermatic arteries; all these nerves are small in the unimpregnated organ, and difficult to follow, but, like the muscular and vascular tissues, they also become enlarged during pregnancy into a great system of nerves, whereby not only are its functions regulated, but a sympathy is also maintained with the entire system. These nerves have been described by Hunter and Tiedmann, and more recently and ably by Lee (Phil. Trans., 1842). The latter has described several nervous ganglia and plexuses in and about this organ, viz., the hypogas-

tric ganglia, which are near the ureters on each side of the cervix, and which receive nerves from the hypogastric plexus, and supply the rectum, bladder, vagina, and uterus, with filaments which form minor ganglions, each named from their situation; the branches of the uterus ascend, and, meeting some from the spermatic plexus, form a large ganglion (spermatic), which supplies the fundus; the filaments from these several ganglia form a sort of nervous network over the entire organ. (*See* Nervous System). The more minute examination of the muscular, vascular, nervous, and mucous tissue in this organ, and of the changes which each undergoes in the several stages of pregnancy, are of great interest; this study belongs, however, to that of the anatomy of the gravid uterus, which does not properly come within the limits of the present work. In the embryo, and previous to the third month, the uterus is found developed as bifid or bicornate, a condition which is permanent in many animals; about the fourth month the two cornua have united to form a single cavity: the two funnel-like depressions in the superior angles, in which are the internal orifices of the Fallopian tubes, correspond with this original conformation. An imperfect septum may co-exist with this bifid form, of which the two median lines or raphes, in the vigina, may be regarded as rudiments. In the fœtus, at birth, the uterus is situated in the abdomen, and is very small; the cervix is longer in proportion than the body or fundus: as the pelvis is developed it gradually subsides into it, but undergoes little change or increase until near puberty, when it rapidly attains its full dimensions and proper form; in old age it becomes atrophied, and is often inclined to one side, or turned backwards towards the rectum; a well-marked constriction then separates the neck and body, the latter becomes thin and softened, the former very dense, and the lips of the os are nearly effaced.

The *Fallopian tubes* or *oviducts* are two in number, one on each side, from four to five inches in length; they extend from the upper angles of the uterus to near the sides of the superior opening of the pelvis, at first straight upwards and outwards, then tortuously downwards and backwards, and a little inwards, loose and floating, supported by the broad ligaments, in the upper border of which they are inclosed behind the round and before and above the ovary and its ligament; its uterine half is small, but the external portion is nearly the size of a goose-quill; its calibre is very contracted throughout, and is like that of the vas deferens, to which this duct is also analogous in its firm, cord-like feel; it opens internally into the upper angle of the womb by a minute foramen, almost capillary (ostium uterinum); externally by a much larger opening into the peritonæal cavity (ostium abdominale); this extremity, named *corpus fimbriatum,* is expanded in a trumpet form; is soft, and irregularly fringed, or, as it were, lacerated; from this appearance, and from the manner in which it is supposed to seize the ovary during conception, the term *morsus diaboli* has been applied to it. The fringes surround the opening by one or two rows or borders; it partly overhangs the ovary, and is connected to it either by one of the fringes, or by a fibrous band, which serves to conduct the tube to that body. This conformation can be well seen when the tube is removed and floated in water; like the uterus, these are composed of three tunics; the external or serous, derived from the broad ligaments, is loose and easily detached; the middle or fibrous, or fibro-muscular, consists of two planes of fibres, external or longitudinal, and internal or circular; they are continuous with those of the uterus, and most probably of the same muscular character: the internal or mucous coat is continuous with that of the uterus internally, and with the peritoneum externally: it is soft, and reddish, and thrown into longitudinal plicæ designed to admit of dilatation; its epithelium is columnar and ciliated; the external fimbriæ are chiefly composed of the mucous and serous tissues; the former

is soft and vascular, the latter very thin; the fibrous coat is wanting, or nearly so; this extremity of the tube is dilatable, and much larger than the uterine portion. The Fallopian ducts are essential to reproduction; they transmit the fecundating principle of the male to the ovary, which they embrace, and then conduct the fecundated ovum into the uterus. The *ovaria* or female testes, are two small oval bodies, white or pale red, flattened before and behind, one at each side, inclosed in the posterior fold of the ligament, behind the Fallopian tube, connected to the uterus by the broad ligament, and by a round, fibrous cord, its proper ligament, which is about two inches long, is inclosed between the laminæ of the broad ligament, and is attached to the inner end of the ovary and to the upper part of the side of the uterus, a little below its superior angle: to its outer extremity, also one of the fringed processes of the morsus diaboli, or a fibrous band, is attached; it is free before, behind, and above: it is composed of a cellulo-vascular tissue inclosed in three tunics, a serous, a fibrous, and a vascular; the serous invests the greater portion of it, and adheres most intimately to the fibrous coat, which is white, strong, and sclerotic; the vascular not only covers it, but is continued into it internally, and assists in forming its areolar tissue. In the cells of this vascular structure, or stroma, a number of small vesicles are developed (Graafian vesicles); these are very variable in number and size; from six to ten or twelve, fully formed, are usually observed, but the microscope reveals numerous ovisacs throughout the parenchyma. This structure is most distinct if examined shortly after parturition, the ovary being then swollen, soft, spongy, and vascular, and the vesicles enlarged. The Graafian vesicles are small, transparent cysts, varying in size from a pin's head to a small pea, containing a transparent, yellowish fluid, and adhering to the stroma; each has two coats, an external or vascular, and an internal (the ovi-capsule), lined with epithelium; in each vesicle there is usually only one ovum at first in its centre, but as it is matured it approaches the inner surface of the internal coat, and becomes surrounded by a granular covering. An *ovum* is a spherical body, of uniform size, about $\frac{1}{120}$ of an inch in diameter, with a thick but transparent coat, which surrounds the yolk; within the latter is the germinal vesicle of Purkinjie, and within this again is the germinal spot of Wagner. (For further information on this subject, and on the changes that follow impregnation, see Muller's Physiol., transl. by Baly; also Carpenter's Human Phys., p. 684). On one or both ovaries we commonly observe an appearance known under the name of *corpora lutea.* A corpus luteum is considered to be the remains of a vesicle ruptured in consequence of impregnation; it is usually a small, yellowish, brownish mass, of a spongy tissue, traversed by white bands, and containing a small cavity which had been occupied by the ovum; it is lined by a puckered membrane, the remains of the ovisac; if recent, the opening from this sac, through the capsule of the ovary, whereby the ovum escaped, is distinct; when this is closed a small cicatrix exists in its situation.

As the ovaries contain the ova, they are essential to reproduction. In the fœtus they are large in proportion, and, like the testes, occupy the lumbar regions, and gradually descend into the pelvis. During pregnancy they are carried up into the abdomen along with the uterus, to the sides of which they are closely applied: shortly after parturition they are situated in the iliac fossæ, and are not unfrequently retained there by adhesions during the rest of life.

The mammary glands have been already examined (page 78).

The female organs of generation are the seat of many *morbid* changes. Not to notice the various ulcerations to which the *external parts* are liable, we occasionally find here also polypi, adipose, and sarcomatous tumors in the labia, enlargement of the clitoris, &c.

The uterus may be found inflamed (matritis); this most frequently occurs

soon after parturition; the adjacent peritoneum is then also generally affected: the uterus itself exhibits the same appearances as other inflamed parts; the inflammation is found to creep along the Fallopian tubes and ovaries. It often advances to suppuration, and pus is generally found in the large veins of the womb. In puerperal peritonitis, it has been remarked, that the extravasated fluid and coagulable lymph are found in a greater proportion to the degree of inflammation, and the lymph softer and more colored, than in common peritonitis. *Polypi* are very frequently found in the uterus; they may grow at any period of life, but they are rarely met with in the young. By a polypus is meant a diseased mass, which adheres to the cavity of the uterus by a sort of neck or narrower portion. Polypus is of two different kinds; the most common is hard, and consists of a substance divided by a thick membranous septa. This sort of polypus varies much in its size, some not being larger than a walnut, and others exceeding in bulk a child's head. Another sort of polypus forms in the uterus, which consists of an irregular bloody substance, with tattered processes hanging from it; when cut into, it appears to be a spongy mass, containing large cells. The most common part to which polypi adhere is the fundus uteri, and sometimes they are found attached to the os tincæ. Hard, fibrous tumors also not unfrequently exist in the parietes of the uterus. One of the most frequent affections of this organ is a granulated state of the os tincæ, giving rise to leucorrhœa. The os, and the parts about it, are covered with minute red elevations, like the surface of a raspberry, and the interstices are covered with a fluid resembling pus, but which is really serum. The uterus is also the seat of cancer, which usually commences near the os tincæ. It is likewise often subject to partial displacement, viz., prolapsus, inversio, and retroversio.

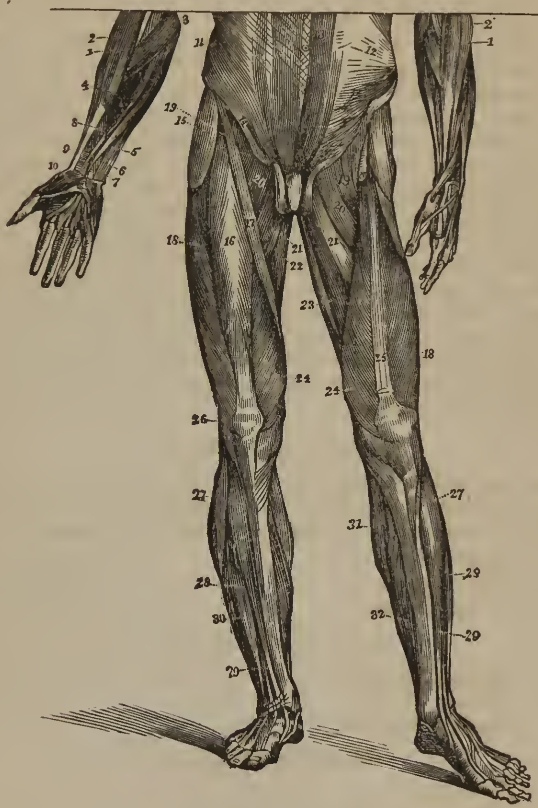
The investing membrane, or the substance of the *ovary*, are very rarely found inflamed, except when they are included in general peritonitis. When the inflammation proceeds from the uterus, or from the cæcum (perityphlitis), as occasionally happens, it sometimes goes on to the formation of pus in the ovary. The most common disease in the ovary is dropsy; the whole substance of the ovarium is sometimes converted into a capsule containing fluid, the natural structure has disappeared, and it is found converted into cells, communicating with one another by considerable openings, and very much enlarged. The ovaria are sometimes converted into a series of cysts, which have no communication with each other: these cysts have been confounded with hydatids, to which they bear some resemblance; they are, however, very different; they have much firmer and less pulpy coats than hydatids; they contain a different kind of fluid, and they are differently connected among themselves. Hydatids either lie unconnected, or one large one incloses a number of small ones; while ovarian cysts adhere to each other by broad surfaces, and do not inclose each other. The ovaria are sometimes converted into cysts, holding large masses of fat, hair, and some teeth: these substances appear to be generated by the internal membrane of the cyst; the hairs are most of them loose in the fatty substance, but many of them adhere to the inside of the capsule; the teeth, which are not always perfect, are sometimes attached to the cyst, and at others to an irregular mass of bone.

CHAPTER VIII.

DISSECTION OF THE INFERIOR EXTREMITIES.

Each inferior extremity is connected to the trunk by the strong ligaments of the hip joint, and by several muscles which pass from the pelvis to the

Fig. 57.*



* The muscles of the anterior aspect of the trunk and extremities; on the right side the superficial layer is seen, and on the left side the deeper layer. 1. 1. Supinator radii longus. 2. 2. Extensor carpi radialis longus. 3. Pronator radii teres. 4. Flexor carpi radialis. 5. Palmaris longus. 6. Flexor digitorum sublimis. 7. Flexor carpi ulnaris. 8. Portion of flexor digitorum sublimis. 9. Pronator quadratus. 10. Abductor pollicis. 11. Portion of obliquus externus abdominis. 12. Portion of obliquus internus. 13. Rectus abdominis. 14. Inferior border of external oblique forming the crural arch. 15. Tensor vaginæ femoris. 16. Rectus femoris. 17. Sartorius. 18. 18. Vastus externus. 19. 19. Femoral portion of the psoas magnus and iliacus internus muscles. 20. 20. Pectinæus muscle. 21. 21. Adductor longus. 22. Gracilis. 23. Part of the adductor magnus. 24. 24. Vastus internus. 25. Cruræus 26. The patella. 27. 27. Tibialis anticus. 28. 28. Extensor digitorum communis. 29. 29. Extensor pollicis proprius. 30. Peronæi muscles. 31. Internal portion of gastrocnemius. 32. Solæus.

thigh and leg. This dissection may be performed while the pelvis remains attached to the spine, or the former may be separated from the lumbar vertebræ, and divided into two.

[The muscles of the inferior extremity are very differently arranged from those of the superior. The great locomotive functions of the inferior extremities are progression and retrogression; accordingly we find that the flexor and extensor muscles are on opposite sides of the limb, and that they change their relative position in each sub-region of the extremity; while in the superior extremity the flexor muscles are all on the same aspect of the limb, and so too with the extensors. Besides flexion and extension, the motions of these extremities include rotation inwards and outwards, adduction and abduction, which movements are effected either by special and appropriate muscles, or by certain of the flexors and extensors: of the former fact we have an illustration, in the rotator muscles of the thigh; of the latter in the tibiales anticus and posticus; the former flexes the foot upon the leg, the latter extends it, yet both together turn the foot inwards and upwards. As in the case of the upper, so in the lower extremities, the muscles should be classed as nearly as possible according to their functions, and we find that they may be examined in the four regions of the hip, the thigh, the leg, and the foot; this arrangement has reference to the part of the extremity upon which the muscle chiefly lies; again in the several regions the muscles are arranged in classes having reference to the particular part of the limb on which they act; and lastly the classes are divided into groups, according to the particular and principal motion effected by their contraction, as flexion, extension, &c. In proceeding with the muscles which act upon the inferior extremity, we examine first the region of the hip, in which we find but one class of muscles, all acting upon the thigh; these are twelve in number, on each side, arranged in three groups, the flexors three, the extensors three, and the rotators six, as follows:

First Group, Flexors.

The psoas parvus is inserted here rather as a matter of expediency than propriety, not because it is a flexor of the thigh, but from its position, and because it is in some respects a congener of the psoas magnus.

1. Psoas Parvus, } 2. Psoas Magnus, }	*Vide p.* 254.
3. Iliacus Internus,	" " 256.

Second Group, Extensors.

1. Glutæus Maximus,	*Vide p.* 313.
2. Glutæus Medius,	" " 314.
3. Glutæus Minimus,	" " 314.

Third Group, Rotators.

1. Pyriformis,	*Vide p.* 315.
2. Obturator Internus,	" " 315.
3. Obturator Externus,	" " 316.
4. Gemellus Superior, } 5. Gemellus Inferior, }	" " 315.
6. Quadratus Femoris,	" " 316.

Of these groups the first is situated anteriorly, for the most part in the abdomen; the second and third are posteriorly, on and about the dorsum of the ilium, and are found in three layers; in the first the glutæus maximus, in the second the glutæus medius, and in the third the glutæus minimus, anteriorly and superiorly, and the six rotators, posteriorly and inferiorly.

The muscles on the region of the thigh are fifteen in number, on each side,

and are arranged in two classes, one acting upon the leg, the other upon the thigh; in the first class there are three groups, the superficial group of three muscles, the flexors four, and the extensors also four; in the second class there is but one group, of four muscles, the adductors.

FIRST CLASS.

First Group.

Three superficial muscles at the outer, fore, and inner part of the thigh.

1. Tensor Vaginæ Femoris, an abductor and rotator of the thigh, and which acts upon the outside of the leg, through the fascia lata,	*Vide p.* 306.
2. Sartorius, a flexor of the leg, and adductor of the whole limb,	" " 306.
3. Gracilis, a flexor of the leg and adductor,	" " 308.

Second Group.

Four extensors of the leg, situated on the anterior aspect of the thigh.

1. Rectus Femoris, which also flexes the thigh upon the pelvis,	*Vide p.* 307.
2. Vastus Externus,	" " 307.
3. Vastus Internus,	" " 308.
4. Crureus or Cruralis, beneath which, at the lower part of the thigh, is sometimes found the Subcrureus,	" " 308.

Third Group.

Four flexor muscles of the leg, situated on the posterior aspect of the thigh.

1. Biceps Flexor Cruris,	*Vide p.* 318.
2. Semi-Membranosus,	" " 318.
3. Semi-Tendinosus,	" " 318.
4. Poplitæus,	" " 328.

SECOND CLASS, ONE GROUP.

Four adductor muscles situated at the inner, back, and forepart of the thigh, and most of which also assist in flexion of the thigh upon the pelvis.

1. Pectinæus,	*Vide p.* 309.
2. Adductor Longus,	" " 309.
3. Adductor Brevis,	" " 309.
4. Adductor Magnus,	" " 310.

The muscles on the region of the leg are twelve in number, on each side, and are arranged in two classes: the first class acts upon the foot, and consists of two groups; one posteriorly, which extends the foot, the other anteriorly, which flexes the foot. The second class consists of two groups, which act primarily upon the toes, and, if that action be continued, secondarily upon the foot.

FIRST CLASS.

First Group.

Six extensor muscles of the foot, situated on the outer and posterior aspects of the leg.

1. Gastrocnemius,	*Vide p.* 325.
2. Solæus,	" " 326.
3. Plantaris,	" " 326.
4. Peronæus Longus,	" " 324.
5. Peronæus Brevis,	" " 324.
6. Tibialis Posticus,	" " 329.

The two first form the calf of the leg and the tendo Achillis; the three first are direct extensors of the foot; the fourth and fifth extend and abduct, while the sixth extends and adducts the foot.

Second Group.

1. Tibialis Anticus, *Vide p.* 322.
2. Peronæus Tertius, " " 323.

The first flexes and adducts, the second flexes and abducts the foot; hence they are both antagonists and congeners of certain muscles in the first group.

SECOND CLASS, TWO GROUPS.

First Group.

Two extensors of the toes, and flexors of the foot, situated anteriorly.

1. Extensor Digitorum Longus, *Vide p.* 322.
2. Extensor Pollicis Proprius, " " 323.

Second Group.

Two flexors of the toes and extensors of the foot, situated posteriorly.

1. Flexor Longus Digitorum Perforans, *Vide p.* 328.
2. Flexor Pollicis Longus, " " 329.

On the region of the foot on either side, we find twenty muscles, which all act upon the phalangeal bones, except the transversalis pedis, which acts rather upon the phalangeal extremities of the metatarsal bones. These muscles are arranged in two classes, the one acting upon the toes generally, the other upon individual toes. In the first class are two groups, chiefly common extensors, and flexors of the toes: in the second class also are two groups, the proper muscles of the great toe, and the proper muscles of the little toe.

FIRST CLASS.

First Group.

One muscle only, situated on the superior or dorsal surface of the foot.

1. Extensor Brevis Digitorum Pedis, *Vide p.* 323.

Second Group.

This group consists of fourteen muscles, situated on the plantar surface of the foot, for the most part. Some of them, however, are between the metatarsal bones, and may be seen both on the plantar and dorsal surfaces of the foot, viz., the seven interossei. Some of these muscles are single, while others are manifold, viz., the four lumbricales and seven interossei.

1. Flexor Brevis Digitorum Pedis Perforatus, *Vide p.* 330.
2. Flexor Digitorum Pedis Accessorius,
3. to 6. The Four Lumbricales, " " 331.
7. Transversalis Pedis, which is somewhat analogous to the palmaris brevis of the hand, except that the latter arches the hand at the carpus, while the former arches the foot at the phalangeal extremity of the metatarsus, " " 332.
8. to 14. The seven Interossei, of which four are seen on the dorsal surface of the foot, three on the plantar surface, and of these last, the third, or most external, is the adductor of the little toe. All seven of these muscles are adductors and abductors of the four lesser toes, " " 333

SECOND CLASS.

First Group.

Three muscles at the under surface and inner edge of the foot, which act upon the great toe only.

1. Abductor Pollicis Pedis,	*Vide p.* 332.
2. Flexor Brevis Pollicis Pedis,	" " 332.
3. Adductor Pollicis Pedis,	" " 332.

Second Group.

Two muscles at the under surface and outer edge of the foot, which act upon the little toe only.

1. Flexor Brevis Minimi Digiti,	*Vide p.* 332.
2. Abductor Minimi Digiti,	" " 330.

We find, then, on taking a review of all the muscles, which operate directly on the inferior extremity, that there are on the region of the hip, anteriorly and posteriorly, twelve muscles; on the region of the thigh, fifteen, without the subcruralis; on the region of the leg, twelve; and on the region of the foot, twenty: in all fifty-nine muscles, or one hundred and eighteen for both. We find, too, that, though each muscle exercises what may be considered its chief and leading motion, still its action is modified by its own course, by its combination with other muscles, and by its own extent: as for example, we find that when a muscle arises in one region, and passes over a second to be inserted into a third, it will act upon both regions, but produce a different and opposite motion in the two; as in the case of the rectus femoris, which arises from the pelvis, passes over the whole length of the thigh, and is finally inserted into the leg, through the patella and its ligament. The leading action of this muscle is to extend the leg upon the thigh, but having done that, it can then flex the thigh upon the pelvis. So too with many other muscles of the extremities.]

SECTION I.

DISSECTION OF THE MUSCLES OF THE THIGH.

Place the extended limb on the back part, raise the integuments from the anterior and lateral parts of the thigh, and from the upper part of the leg; several cutaneous nerves, veins, and lymphatic vessels are met with in this dissection; the nerves are branches of the lumbar plexus and of the anterior crural nerve; they pierce the fascia lata near Poupart's ligament, and descend chiefly along the anterior and outer side of the thigh. The cutaneous veins are branches of the internal saphena vein. This vessel will be found, when dissecting the leg and foot, to commence at the inner side of the latter, and to ascend along the internal part of the leg and knee to the inner and forepart of the thigh, along which it continues its course to the groin; about an inch and a half or two inches below Poupart's ligament it pierces the fascia lata, and joins the femoral vein. In this course it receives several cutaneous branches, and, in general, just before it ends in the femoral, it is joined by one or two large veins from the outer and forepart of the thigh, and by some smaller branches from the abdominal parietes; some cutaneous branches from the anterior crural and lumbar nerves accompany this vein in its course

along the thigh. Beneath the integuments the thigh is invested by the superficial fascia, which is prolonged around it from the parietes of the abdomen. In the groin this fascia is thick and laminated, and closely connected to the fascia lata, particularly to its cribriform portion; but inferiorly and posteriorly it is thin and loose, as ordinary sub-cutaneous cellular tissue. This fascia may be easily detached from the fascia lata, except in the groin; in attempting to raise it in this region we expose the superficial inguinal glands, some of which lie between its laminæ; they are eight or ten in number; five or six of them are placed parallel to Poupart's ligament, some above, others below it; two or three are situated lower down in the groin than these, near the termination of the saphena vein. These last glands lie on the fascia lata; they are larger than the former, and are parallel to the saphena vein. Through these conglobate glands the superficial absorbents of the lower extremities pass, also those from the external parts of generation. Beneath the fascia lata, close to, and generally internal to the femoral vessels, are the deep-seated inguinal glands; small, only three or four in number; they transmit the deep-seated absorbents of the limb. The integuments and superficial fascia having been removed, the *fascia lata*, or *crural*, or *femoral aponeurosis*, may be next examined. This aponeurosis surrounds the thigh; it is very strong and tendinous externally, but so thin and weak internally, that without caution it may be removed along with the integuments; it is attached superiorly and externally to the crest of the ilium; posteriorly to the sacrum and coccyx: on the glutæus maximus it is weak and thin, but at the anterior border of this muscle it becomes very strong, receiving an addition of fibres both from the tendon of that muscle and from the tensor vaginæ femoris; anteriorly it is attached to Poupart's ligament, and internally to the rami of the ischium and pubis; as it extends down the thigh it confines the different muscles in their situation, so as to preserve the figure of the limb; several processes also pass inwards to form septa and sheaths for some muscles, and to bind others in their place: to many of these processes the muscles adhere, so that when in action they serve to make the fascia more tense and resisting; this is especially the case with the glutæus maximus and the tensor vaginæ: these processes also serve to increase the surface of origin or attachment of several muscles. Along the posterior part of the thigh it is connected to the whole length of the linea aspera, also to the insertion of the glutæus maximus, and to the origin of the short head of the biceps; inferiorly it adheres to the condyles of the femur, surrounds the knee-joint, and receives an addition of fibres from the different tendons in this region; a bursa separates it from the patella; below the knee it is continued over the heads of the tibia and fibula into the fascia of the leg. Numerous foramina are observable in the fascia lata, particularly at the upper and anterior part of the thigh; they transmit cutaneous nerves and vessels: the most remarkable of these holes is that for the saphena vein; it is situated on the anterior and inner aspect of the thigh, about an inch and a half or two inches below Poupart's ligament, and may be most distinctly seen by dividing the vein below, and raising it towards the abdomen. This opening is semilunar, the concavity directed upwards; from its apparently sharp edge the fascia is reflected backwards, and is lost on the sheath of the femoral vessels. That part of the fascia which is internal to this opening is named the pubic portion of the fascia lata; it covers the pectinæus muscle, adheres to the spine and linea innominata of the pubis, extends behind the femoral vessels, and divides into two laminæ; one is continuous with the fascia iliaca, in front of the psoas and iliac tendon; the other passes deeper and behind this tendon to join the ilio-femoral capsule; that part of the fascia lata external to the saphenic opening is called the iliac portion; it covers the sartorius, tensor vaginæ, rectus, and iliacus internus muscles, and is continued obliquely in front of the femoral

vessels, in the form of a *crescentic* or *falciform process*, the concavity of which is directed downwards and inwards; the convexity is towards the ilium, and attached to Poupart's ligament; the lower cornu of this crescentic process is continuous with the outer cornu of the saphenic opening, and the upper cornu extends in front of the femoral vessels to their inner side, and is inserted along with the third insertion of Poupart's ligament, or Gimbernaut's ligament, into the linea innominata, or ileo pectinæa. Between the margin of the falciform process and the pubic part of the fascia lata is a thin membrane, perforated by numerous vessels; this is termed the *cribriform fascia;* it is connected on either side to the iliac and pubic portions of the fascia lata, and may be regarded either as a thin lamina of the fascia lata connecting these two lateral portions, or as a deep layer of the superficial fascia; it extends from the saphena vein to Poupart's ligament, in front of the sheath of the femoral vessels; it adheres to the anterior part of this sheath, or to the fascia transversalis; when this cribriform fascia is removed the falciform process is made more distinct. (*See* Description of Crural Hernia, page 188.) The fascia lata, in some situations, particularly along the outer side of the limb, is seen to consist of two laminæ of fibres; the external takes a circular, the internal a longitudinal direction; these two laminæ are very distinctly separated at the upper and outer part of the thigh, by the insertion of the tensor vaginæ femoris; the deep layer, which in this situation is very strong, is attached to the capsular ligament of the hip joint, and to the external head of the rectus muscle; of its intermusclar septa, two are very strong, external and internal; the *external* extends from the great trochanter to the external condyle, attached to the linea aspera; the vastus externus adheres to it in front, the short head of the biceps behind; it is pierced above by the external circumflex, and below by the external articular vessels. The *internal* intermuscular septum arises from the anterior intertrochanteric line, and is inserted into the inner condyle, adheres to the linea aspera between the vastus internus and the adductor tendons. These two great septa separate the front from those on the inner and back part of the thigh; between the two latter regions again a weaker septum is interposed, so that there are three principal muscular compartments, one for the posterior, another for the internal, and a third for the anterior muscles; and the two latter compartments are subdivided into sheaths for the separate muscles, as will be seen in the course of their dissection. Raise the fascia lata from the anterior and lateral parts of the thigh; several muscles will come into view, the femoral vessels also in the groin will be partially exposed; they are still somewhat concealed by a quantity of adipose substance, by a few deep-seated lymphatic glands, and by their anterior sheath or the fascia transversalis; when the former are removed, and the latter opened, we always find the vein internal to the artery, and about an inch and a half from the spine of the pubis: immediately external to the vein is the artery resting on the psoas, and about a quarter of an inch external to the artery is the anterior and crural nerve, imbedded between the psoas and iliacus, and covered by the fascia iliaca; it does not, therefore, lie in the sheath of the vessels: internal to the vein, between it and the inner wall of the sheath, is the femoral ring. Clean the several muscles which now partially appear on the forepart of the thigh: external to the vessels the sartorious and tensor vaginæ are first seen; internal to the vessels are the pectinæus, gracilis, and the three adductors; and immediately covering the anterior and lateral parts of the femur are the rectus, cruræus, vastus internus, and externus.

SECTION II.

MUSCLES ON THE FOREPART AND SIDES OF THE THIGH.

These are eleven in number.

1. Tensor vaginæ femoris, at the upper and outer part of the thigh, narrow above, broad and thin below, *arises* tendinous and fleshy from the external part of the anterior superior spinous process and crest of the ilium; it forms a fleshy belly, which descends obliquely backwards, and is *inserted*, broad and thin, into a duplicature of the fascia lata on the outside of the thigh, about three or four inches below the great trochanter. *Use*, to make tense the fascia, and compress the vastus externus; to rotate the thigh inwards; also to assist in flexing and abducting it. The origin of this muscle is between the sartorius and glutæus medius; between these muscles it descends, covered by the fascia lata; its insertion is anterior to that of the glutæus maximus muscle.

Fig. 58.*

2. Sartorius, or the tailor's muscle, is the longest muscle in the body, thin and flat like a ribbon, broader in the middle than at the extremities, situated obliquely along the anterior and inner side of the thigh, *arises* by short, tendinous fibres from the anterior superior spine of the ilium, and from the notch below that process, it soon becomes broad and fleshy, extends obliquely across the thigh to its inner side, and, descending perpendicularly to the knee, passes behind the condyle of the femur; it then turns forwards and outwards towards the inner side of the upper end of the tibia, into which it is *inserted* below the tubercle by a long, flat tendon, the anterior edge of which is attached to the fascia lata covering the knee-joint, and the posterior edge sends off an aponeurosis to the fascia of the leg. *Use*, to flex the leg upon the thigh, also the latter on the pelvis; to adduct the thigh and leg obliquely, so as to cross the lower extremities, or to place one foot on the opposite knee; when the thigh and leg are extended, it assists in raising and advancing forwards the whole limb, also in turning the knee outwards; in standing it also supports the pelvis, and prevents it bending backwards on the thigh; it may then also flex the body, and rotate it to the opposite side. This muscle through its whole extent is covered only by the fascia lata and the integuments; its superior extremity lies between the tensor vaginæ and the iliacus internus muscles; its inferior extremity expands into a strong aponeurosis, which covers and adheres to the tendons of the semi-tendinosus and gracilis muscles, anterior and superficial to both of which it is in-

* The muscles on the forepart and sides of the thigh. 1. The internal iliac fossa. 2. The crest of the ilium. 3. The anterior-superior spine of the ilium. 4. The anterior portion of the glutæus medius. 5. The tensor vaginæ femoris muscle, cut off just below its insertion into the fascia lata. 6. The sartorius. 7. The rectus femoris. 8. The vastus externus. 9. The vastus internus. 10. The patella. 11. The inferior portion of the internal iliac and psoas muscles. 12. The pectinæus muscle. 13. The adductor longus. 14. Part of the adductor magnus. 15. The pubis.

serted, a bursa being usually interposed; in its course along the thigh it first passes over the psoas, iliacus, and rectus muscles; next over the vastus internus and adductor muscles, saphenous nerve, and the femoral vessels; is separated from the latter by a strong aponeurosis; inferiorly it passes over the internal lateral ligament of the knee, between the tendons of the adductor magnus and the gracilis. The superior third of this muscle extends in an oblique direction from the ilium downwards and inwards, forms the external boundary of the inguinal region, lies to the outer side of the femoral vessels, and serves as a guide to the operator when exposing them; the middle third is more vertical in its course, and is about two inches broad, and completely covers the femoral vessels, also a part of the adductor and vastus internus muscles; the lower third is in a groove between the gracilis and vastus internus; near the knee the saphenous nerve is anterior, and the vein behind it.

3. Rectus Femoris, long and flat, rather round and thick in the centre, placed vertically on the forepart of the thigh, *arises* by two tendons, one straight, short, strong, anterior, and internal, from the anterior inferior spinous process of the ilium, the other longer, broader, and more curved, from the superior and external border of the acetabulum, and from the capsular ligament; these tendons soon uniting form a strong, fleshy belly, which descends almost vertically, with a slight inclination inwards. This muscle has a peculiar penniform appearance; it is also tendinous anteriorly in the upper half, so that the sartorius can glide over it, and tendinous posteriorly in the lower half, whereby it can move on the surface of the cruræus; ends in a flat tendon, is *inserted* along with the vasti and cruræus into the upper edge of the patella; a few fibres pass anterior to this bone, and are continued into the ligamentum patellæ, which descends obliquely outwards to the tubercle of the tibia. *Use*, to extend the leg on the thigh, and flex the thigh on the pelvis; it supports the pelvis in a state of equilibrium, but can also bend it forwards on the thigh, and it strengthens the capsular ligament of the hip joint; its action is facilitated by the patella, which changes the direction of its force, by increasing the angle of insertion, and this is still further secured by the tendon and ligamentum patellæ being inserted into the anterior surface of the bone, and not into its posterior rough margin: the rectus tendon and the ligamentum patellæ form an angle concave outwards; the tendency, therefore, of this muscle, is to prevent the patella being pushed inwards by any external force; this circumstance, however, favors dislocation of this bone, which always occurs in a direction outwards; in some persons, in whom the knees incline too much inwards, this angle is very obtuse, and dislocation therefore more likely to occur. The anterior tendinous origin of this muscle is covered by the sartorious, tensor vaginæ, and iliacus internus muscles; the posterior by the glutæus medius and minimus muscles; the remainder of the muscle is only covered by the integuments and fascia; superiorly this muscle lies on the capsular ligament of the hip joint and the external circumflex vessels; in the rest of its course, on the cruræus and vasti muscles, to which it is united below, so that these four are really one muscle, a *quadriceps extensor cruris*. Beneath the rectus we find this large mass of muscular substance covering the front and sides of the femur; it may be divided superiorly into three portions, but inferiorly these are inseparably united; the external portion is named vastus externus, the internal vastus internus, and the middle cruræus.

4. Vastus Externus, much larger than the other portions, and larger above than below, *arises* tendinous and fleshy from the root and anterior part of the great trochanter, anterior to the tendon of the glutæus maximus, from the outer edge of the linea aspera, its whole length, and from the oblique ridge which leads to the external condyle, anterior to the short head of the biceps; from all the external surface of the bone, and from the fascia lata, and its external septum; the fibres descend obliquely forwards, the superior

are very long, the inferior are shorter and more transverse, *inserted* into the external surface of the tendon of the rectus, also into the side of the patella, and by an aponeurosis, which adheres to the synovial membrane of the knee-joint, into the head of the tibia. *Use*, to extend the knee, also to rotate the leg outwards; this muscle is partly concealed by the rectus; its external surface is tendinous above and fleshy below, its internal is fleshy above and tendinous below; covered by the fascia lata and its tensor, and by the tendon of the glutæus maximus.

5. Vastus Internus, smaller and shorter than the last, narrow above, but broad below; *arises* on the anterior part of the femur, from the inter-trochanteric line; from the inner edge of the linea aspera, its whole length, also from the inner side of the femur, the fibres descend obliquely forwards, and are *inserted* into the inner edge of the tendon of the rectus, also into the patella, and by an aponeurosis, which covers the inner side of the synovial membrane of the knee, into the head of the tibia. *Use*, to extend the knee and turn the leg a little inwards. The vastus internus is partly concealed by the rectus and sartorius, its origin lies anterior to the insertion of the psoas, pectinæus, and adductor muscles, and overlaps the cruræus, so as to be in contact with the vastus externus; its internal surface is tendinous above and fleshy below; an aponeurosis from the two vasti covers the patella and its ligament, also the sides of the joint; this aponeurosis is inserted into the head of the tibia, it serves to support the patella in its situation, and to protect the sides of the articulation like a capsular ligament; a small bursa is situated over the patella, between this aponeurosis and the skin;. the insertion of the vastus externus into the patella overlaps that of the vastus internus, and both overlap the cruræus, from which the vastus externus can be more easily separated above, but the vastus internus below.

6. Cruræus, shorter than either of the vasti, between which it lies, larger and more tendinous below than above, *arises* fleshy from the anterior and external part of the femur, commencing at the intertrochanteric line, and extending along three-fourths of the bone, as far outwards as the linea aspera; it does not adhere to the inner side of the femur, there being a portion of the latter, nearly an inch in breadth, and extending almost the whole length of the bone, to which no muscular fibre adheres; the cruræus descends close to the femur to its inferior third, the fibres then incline forwards, become tendinous posteriorly, and are separated from the bone by a large bursa, and by a considerable quantity of fat; *inserted* into the upper and anterior edge of the patella, also into the synovial membrane of the knee behind the vasti, particularly the external, to which it is here intimately united. *Use*, to assist the vasti and the rectus in extending the leg. This muscle is covered by the rectus and the vasti, from the latter it can only be separated superiorly by tearing a few muscular fibres, and tracing some large nerves and vessels that pass between them. The large bursa, which is situated behind the lower part of this muscle, is attached to and frequently communicates with the synovial membrane of the joint. A few muscular fibres are generally attached to this membrane, and have been described as a distinct muscle, the Subcruræus or Capsular; this *arises* from the anterior surface of the femur, about its inferior fourth, passes forwards and downwards, and is *inserted* into the synovial membrane. *Use*, to raise the synovial membrane in extension of the leg, so as to prevent its being contused by the patella.

7. Gracilis, flat, long, and thin, broad and fleshy above, round and tendinous below, situated at the inner side of the thigh, immediately beneath the integuments and fascia; *arises* by a broad, thin, short tendon from the lower half of the symphysis, and from the inner edge of the descending ramus of the pubis; it soon becomes fleshy, and descends vertically, one edge directed forwards, the other backwards, and its surfaces looking one inwards, the other

outwards; about the inferior fifth of the thigh it ends in a round tendon which passes behind the inner condyle, and then turns forward along with the tendon of the sartorius, behind and beneath which it lies; *inserted* into the superior part of the internal surface of the tibia, uniting in a common aponeurosis with the sartorius and semi-tendinosus, but superficial to the latter. *Use*, to adduct the leg and thigh, to bend the knee, and turn the leg and foot inwards. The origin of the gracilis is between the triceps and the crus penis; its whole course is superficial, except near the knee, where it is covered by the sartorius; its insertion is inferior to that of the sartorius, and superior to that of the semi-tendinosus; the saphena vein and nerve are situated between its tendon and that of the sartorius at the inner side of the knee, but these are separated from each other by a fascia, which attaches these tendons together, the vein lying superficial: from the tendon of the gracilis an aponeurosis is sent off to the fascia of the leg.

8. Pectinæus, flat, triangular, broad above, situated at the superior, anterior, and internal part of the thigh; *arises* fleshy from the linea innominata, and the concave surface below it on the horizontal ramus of the pubis, between the spine of that bone and the ilio-pectinæal eminence; it forms a flat, fleshy belly, which descends obliquely outwards and backwards, and, becoming narrower and a little twisted, is *inserted* by a flat tendon into the rough ridge which leads from the lesser trochanter to the linea aspera. *Use*, to abduct and flex the thigh, also, to rotate it outwards; it may also serve to strengthen the capsular ligament of the hip joint internally, and in adduction of the limb to draw the capsule inwards from between the neck of the femur and the acetabulum. It lies between the psoas magnus and the adductor longus; the latter overlaps it, covered superiorly by the fascia lata, and inferiorly by the femoral vessels, the fascia intervening; it covers the obturator nerve and vessels, the external obturator muscle, and the adductor brevis; it also adheres to the capsular ligament of the hip joint.

Triceps Adductor Femoris consists of three portions, which pass in distinct laminæ from the pelvis to the thigh.

9. Adductor Longus, flat and triangular, base below, is situated at the upper and internal part of the thigh, superficial to the other adductors and to the pectinæus; it *arises* by a short, small, but strong tendon from the anterior surface of the pubis, between its spine and the symphysis; this ends in a broad, fleshy belly, which descends obliquely backwards and outwards, and is *inserted* by a broad, thin tendon into the middle third of the linea aspera, between the adductor magnus and the vastus internus, to both of which it is closely united. The origin of this muscle lies between the pectinæus and the gracilis, and above the adductor brevis; its insertion is behind the vastus internus, and in front of the profunda artery, and adductor magnus; is covered by the integuments and fascia superiorly, and by the sartorius and femoral vessels inferiorly; and there forms the posterior wall of that remarkable fibrous tube which incloses the femoral vein and artery in the middle of the thigh: it lies anterior to the two following muscles; its tendon is perforated by vessels.

10. Adductor Brevis, thick and fleshy, short, flat, and triangular, is situated posterior to the adductor longus and pectinæus, and internal to the psoas; *arises* flat and tendinous from the anterior inferior surface of the pubis, between the gracilis muscle, the symphysis pubis, and the thyroid hole; it soon ends in a fleshy belly, which passes outwards, backwards, and a little downwards, *inserted* by tendinous slips into the superior third of the internal root of the linea aspera, extending for about three inches below the lesser trochanter; its origin is external to the gracilis, and internal to the obturator externus, and concealed by the adductor longus and pectinæus; as it descends it is covered by these muscles, except a small portion near its insertion, which

appears between them; this portion is posterior to the femoral and profunda vessels; its insertion is anterior to that of the adductor magnus: in its tendon one or two large openings frequently exist for the passage of some of the perforating arteries.

11. ADDUCTOR MAGNUS, the longest and largest of the adductors, very thick internally, triangular, the base attached to the femur, the apex to the pelvis; composed of thick and separate fasciculi like the glutæus maximus; *arises* chiefly fleshy from the anterior surface of the descending ramus of the pubis, external to the gracilis, also from the ramus of the ischium, and tendinous from the external border of the tuberosity of the latter; the fibres pass outwards with different degrees of obliquity; those which arise from the pubis ascend obliquely outwards, those from the ramus of the ischium pass outwards and downwards, and those from the tuber ischii more directly downwards; *inserted* fleshy into the rough ridge which leads from the great trochanter to the linea aspera, tendinous and fleshy into the linea aspera, and by a long round tendon into the internal condyle of the femur, immediately above the inner tendon of the gastrocnemius. This muscle forms a septum between the inner and back part of the thigh; its superior edge has a twisted appearance, is nearly parallel to the quadratus femoris; several branches of the internal circumflex vessels pass between these, and in rotation of the leg inwards the lesser trochanter also projects between them; the middle portion, which is inserted into the linea aspera, is internal to the insertion of the glutæus maximus, and to the origin of the short head of the biceps. This part of the muscle is perforated by several branches of the perforating arteries; at the lower part of the linea aspera it appears to separate into two portions, one of which is inserted into this line, between the vastus internus and the short head of the biceps; the other is continued into the long tendon, which is inserted into the inner condyle; the femoral vessels pass between these into the popliteal space. The adductor magnus is covered internally by the gracilis, and anteriorly by the long and short adductors, pectinæus, part of the sartorius, and the femoral vessels; posterior to it are the sciatic nerve and the hamstring muscles; the tendinous insertion of the lower part of this muscle is intimately connected to the vastus internus. About the inferior fourth of the thigh there is a large oblique opening, bounded by these two muscles and by the adductor longus, through which the femoral vessels pass into the popliteal space. This muscle, particularly its origin, should also be examined on its posterior aspect, where it is covered by the three hamstrings, the sciatic nerve, and a large quantity of cellular and adipose tissue; in this aspect its division into two is more distinct; the superior or external portion passes more transversely outwards, consists of distinct fasciculi, the aponeurotic insertions of which are united with the other adductors, forming arched and incompressible openings for the passage of the femoral vessels, and for three or four perforating branches of the profunda artery; the internal portion principally arises from the tuber ischii, descends nearly vertical, and ends in the tendon which is inserted into the inner condyle. *Use*, the three adductors in addition to adducting the limb, can rotate it outwards; they also serve to steady and support the pelvis on the thigh; the long and short adductors can also flex the thigh on the pelvis, and the adductor magnus can extend it when it has been flexed.

In dissecting the preceding muscles we observe the following vessels and nerves:

The *Femoral Artery* passes from under Poupart's ligament, about midway between the symphysis pubis and the spine of the ilium, descends obliquely inwards and backwards, and about the lower part of the middle third of the thigh perforates the adductor magnus, enters the popliteal space, and then receives the name of popliteal artery. In the upper third of the thigh,

or in the inguinal region, it is covered only by the skin, superficial fascia, some lymphatic glands, and the fascia lata; in the middle third of the thigh it receives the additional covering of the sartorius, and beneath this of a very strong tendinous aponeurosis, which passes from the tendons of the adductor longus and magnus over the artery and vein, and joins the tendon of the vastus internus. In this part of the thigh it is thus inclosed in a perfect tendinous sheath, consisting anteriorly of the aponeurosis just mentioned, posteriorly and internally of the tendons of the adductor longus and magnus, and externally of the vastus internus: at the lower end of this sheath it passes into the ham, through a large oval opening, which is bounded superiorly by the adductor longus and magnus, externally by the vastus internus, internally by the adductor magnus, and inferiorly by the united tendons of the adductor magnus and vastus internus. The femoral artery in this course first passes over a few fibres of the psoas, next over the pectinæus and adductor brevis, the adductor longus, and a small portion of the magnus: immediately below Poupart's ligament gives off, 1st, some cutaneous branches; 2nd, small arteries to the inguinal glands; 3rd, about two inches below Poupart's ligament, a very large branch, the profunda; 4th, several muscular branches to the sartorius and vastus internus; and 5th, just before it enters the ham, the anastomotica magna, which is distributed to the muscles and integuments at the inner side of the knee. The *profunda* is the largest branch of the femoral; it descends behind that vessel and to its inner side, and gives several branches to the muscles of the thigh, namely, the external and internal circumflex, and the three or four perforating arteries. (*See* Anatomy of the Vascular System.) The *femoral* vein takes the same course as the artery; in the groin it always lies to its internal or pubic side, but as it descends it becomes posterior to it. In dissecting the muscles on the forepart of the thigh, numerous branches of the *anterior crural nerve* are met with. This nerve in the groin is separated into several branches; many of these become cutaneous, others pass to the muscles on the forepart of the thigh, and two or three accompany the femoral artery; one of these, the *nervus saphenus*, enters its tendinous sheath, and, descending along the forepart of the artery, as far as the opening in the tendon of the triceps, then leaves that vessel, descends between the tendons of the sartorius and gracilis muscles to the inner side of the knee, becomes cutaneous, and, attaching itself to the saphena vein, accompanies this vessel along the inner side of the leg to the internal ankle. (*See* Anatomy of the Nervous System.)

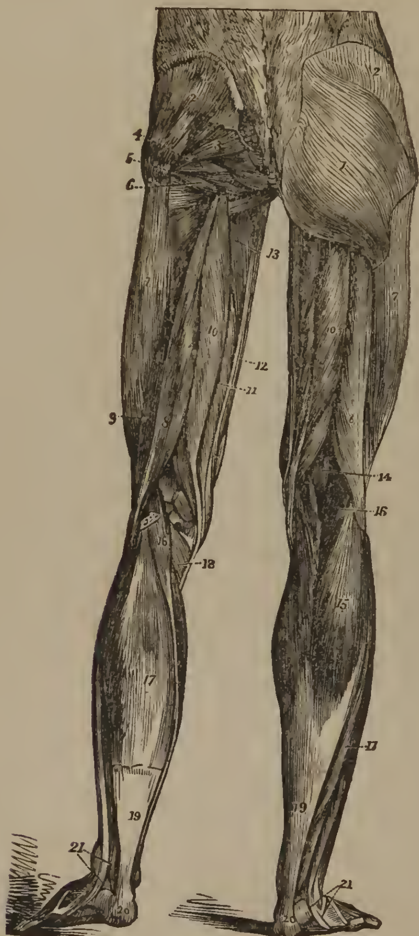
SECTION III.

DISSECTION OF THE POSTERIOR PART OF THE THIGH.

Place the detached extremity on its forepart, with a block beneath the hip joint, so as to flex the latter slightly, and thus extend the muscles in this region. Raise the integuments from the posterior surface of the limb, from the crest of the ilium to the calf of the leg. The cutaneous nerves which are met with in this dissection are branches from the lumbar nerves, from the sacral plexus, and from the sciatic nerve. The cutaneous veins pass in different directions, some turn round the inner side of the limb to the saphena vein, others penetrate between the muscles, and join the deep veins which accompany the muscular or the perforating arteries, and others descend to the popliteal space, and join the popliteal or the lesser saphena vein. The fascia lata over the glutæus maximus is weak, but anterior to that muscle, that is, covering the

glutæus medius, it is very strong, and adheres to the surface of this muscle, and to the crest of the ilium above it. On the posterior part of the thigh the fascia is not so dense as on the outer or the anterior part; inferiorly, over the popliteal region, or the ham, it is much stronger than above; from the thigh it is continued over the muscles of the leg, in which situation it may be examined afterwards: the fascia and integuments being removed, the muscles should be cleanly dissected; these may be divided into the muscles of the hip and of the thigh.

Fig. 59.*



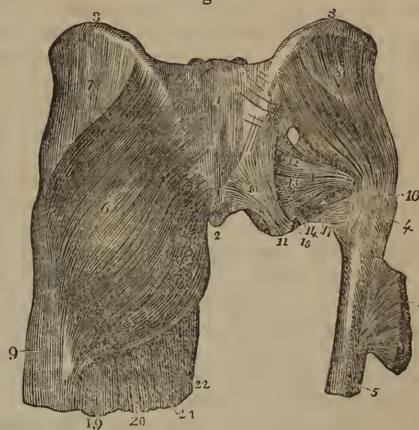
* The muscles on the posterior aspect of the thigh and leg; part of the superficial layer has been removed on the left side. 1. The glutæus maximus. 2. 2. The glutæus medius. 3. Part of the pyriformis muscle. 4. The superior gemellus. 5. Portion of the obturator internus. 6. The inferior gemellus. 7. 7. The vastus externus, covered on the right side by the fascia lata 8. 8. The long head of the biceps flexor cruris. 9. Its short head. 10. 10. The semi-tendinosus. 11. The semi-membranosus. 12. The gracilis. 13. Part of the adductor magnus. 14. The popliteal region. 15. The gastrocnemius muscle. 16. 16. The plantaris. 17. 17. The solæus. 18. The popliteus. 19. 19. The tendo Achillis. 20. 20. The os calcis. 21. 21. The tendons of the peroneus longus and brevis passing behind the external malleolus.

SECTION IV.

DISSECTION OF THE MUSCLES OF THE HIP.

These are nine in number, viz., the three glutæi, the pyriformis, the gemini, the two obturator, and the quadratus femoris.

Fig. 60.*



1. Glutæus Maximus covers the greater part of the pelvis, also the upper part of the thigh; it is somewhat square, one edge being the origin and attached to the sacrum, the opposite edge or the insertion to the femur, and to the fascia lata, the other edges are directed one upwards and forwards, the other downwards and backwards. The inferior edge is thick and round, and covered by a great quantity of fat; this forms the *fold of the nates.* It is difficult to clean the surface of the glutæus maximus, its fasciculi are so coarse and rough; this may be facilitated by dissecting parallel to the fibres, that is, in a line drawn from the sacrum towards the great trochanter. This muscle *arises* by fleshy and short aponeurotic fibres from the posterior fifth of the crest of the ilium, from the rough surface between the crest and the superior semicircular ridge on this bone, from the posterior sacro-iliac ligaments and lumbar fascia, from the tubercles on the posterior surface of the sacrum, the side of the coccyx, and from the great sciatic ligaments, which last it covers; the fibres are collected into distinct fasciculi, which descend obliquely outwards and forwards, nearly parallel to each other, converging a little towards the thigh: the lower fibres are the longest, they all form a strong and dense mass, particularly below, and end in a flat and thick tendon, whose external surface is rough and coarse, but the internal smooth, and lined by a bursa which separates it from and allows it to glide over the great trochanter; this tendon is *inserted* into a rough ridge, which leads from the trochanter to the linea aspera, also into the upper third of that line, and by a tendinous expansion into the fascia lata, covering the vastus externus muscle. *Use*, to extend the thigh, also to abduct and rotate it outwards, to support and extend the pelvis and the trunk on the lower extremity, also to make tense the fascia lumborum and the fascia lata. The glutæus maximus is covered by the integu-

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* The muscles of the hip. 1. The posterior surface of the sacrum covered by a dense aponeurosis. 2. The os coccygis 3. 3. The crest of the ilium. 4. The external surface of the great trochanter. 5. The linea aspera of the femur. 6. The glutæus maximus muscle. 7. A portion of the glutæus medius covered by the fascia lata. 8. The same muscle on the opposite side exposed. 9. The vastus externus muscle covered by the fascia lata. 10. The great sacro-sciatic ligament. 11. The tuberosity of the ischium. 12. The pyriformis muscle. 13. The superior gemellus. 14. A portion of the obturator internus. 15. The inferior gemellus. 16. The tendon of the obturator externus. 17. The quadratus femoris. 18. The tendon of the glutæus maximus thrown down to show its insertion. 19. The biceps femoris muscle. 20. The semi-tendinosus. 21. The semi-membranosus. 22. The gracilis muscle.

ments, by a considerable depth of fat, and by a thin fascia; the fat is most abundant towards the lower part, where it forms an elastic cushion in the sitting posture; this structure is continuous with a very loose cellulo-adipose tissue, which covers the tuber ischii, and which allows the muscle to glide over that projection. As the fascia approaches the upper edge of the muscle, it becomes more strong and adherent, and is thence extended over the anterior part of the glutæus medius, to which it adheres very closely, and is then inserted into the crest and anterior spine of the ilium. The glutæus maximus covers the tuber ischii and all the muscles on the posterior part of the pelvis, except the anterior portion of the glutæus medius, which is covered by the fascia just now mentioned; its insertion into the linea aspera is above the short head of the biceps, and between the vastus externus and adductor magnus; a very large bursa lines its tendon, and is expanded over the trochanter and a portion of the vastus externus; it is very thin, it usually contains much synovial fluid, and it is frequently intersected by tendinous bands: a smaller bursa is often situated below it, between the tendons of the glutæus maximus and vastus externus.

Divide this muscle by a perpendicular incision, and separate the edges. Several muscles, vessels, &c., may be noticed, having the following relation to each other: commencing above, we see the glutæus medius muscle, beneath this the pyriformis, and between these the glutæal vessels and the superior glutæal nerve; below the pyriform muscle the great sciatic and some smaller nerves, also the sciatic and pudic vessels, all escaping from the pelvis by the lower part of the sciatic notch. Next in order are the gemini muscles surrounding the tendon of the obturator internus; below these is the quadratus femoris, parallel to the superior fibres of the adductor magnus; the great sciatic ligament, the tuber ischii, and the superior attachment of the hamstring muscles, are all seen in this dissection, also several small arteries and veins, and a considerable quantity of loose, watery, cellular tissue, which surrounds the sciatic nerve in its course through the depression between the trochanter and tuber ischii.

2. Glutæus Medius, triangular, flat, thinner than the last described muscle, is exposed by dividing the glutæus maximus and dissecting off the strong fascia, which extends from its anterior edge to the crest of the ilium; *arises* by fleshy and aponeurotic fibres from the deep surface of this fascia, from the three anterior fourths of the outer edge of the crest of the ilium, from the superior semicircular line or ridge which leads from the anterior spinous process of the ilium to the upper part of the sciatic notch, and from the surface of the ilium, above and below that ridge. The fibres descend in different directions; the middle perpendicularly, the anterior, which are very short, and the posterior, which are long, obliquely; they all converge into a strong and broad tendon, which is *inserted* into the upper and outer part of the great trochanter, and is attached anteriorly to the tendon of the glutæus minimus. *Use*, to abduct the thigh; its posterior fibres can extend and rotate it outwards, its anterior fibres can flex and rotate it inwards; it also serves to maintain the pelvis in equilibrio on the femur, as when standing on one leg. This muscle is covered in part by the glutæus maximus; the anterior and larger portion is covered only by the integuments, the fascia lata, and its tensor; it lies on the glutæus minimus, its posterior edge is parallel to the pyriform muscle, and separated from it by the glutæal vessels and nerves; the anterior edge is nearly parallel to and behind the tensor vaginæ muscle, is united to it above, but separated from it below by a quantity of fat, and by several branches of the external circumflex vessels and nerves.

3. Glutæus Minimus is exposed by detaching from its origin the glutæus medius; small, semicircular, more tendinous than the last, it *arises* from the inferior semicircular ridge on the dorsum of the ilium, and from the rough

surface between it and the edge of the acetabulum; the fibres converge as they descend, and end in a strong, round, twisted tendon, which is *inserted* into the upper and anterior part of the great trochanter, first passing over a small bursa. *Use*, similar to the last; it also strengthens the ilio-femoral articulation, and as it adheres to the capsular ligament it can draw this out of the joint in abduction of the thigh. This muscle is covered by the glutæus medius, and a little overlapped by the tendon of the pyriformis; it covers the capsular ligament and the external tendon of the rectus. The six glutæi muscles are most powerful agents in maintaining the body in the erect posture, by resisting the tendency which its weight has to bend it forwards, hence these muscles are developed in man to a degree superior to any other animal.

4. Pyriformis is of a flattened, triangular form, the base at the sacrum within the pelvis, the apex at the trochanter; situated partly within the pelvis, partly behind the hip joint, nearly parallel to the posterior border of the glutæus minimus; it *arises* within the pelvis by three tendinous and fleshy fasciculi, from the anterior or concave surface of the second, third, and fourth divisions of the sacrum; it also receives a few fibres from the anterior surface of the great sciatic ligament, and from the upper and back part of the ilium; the fibres form a thick, fleshy belly, which, passing through the great sciatic notch, descends obliquely outwards and a little forwards, and is *inserted* by a round tendon into the upper part of the digital fossa, at the root of the great trochanter above the tendons of the gemini and obturator muscles, to which it is connected. *Use*, to abduct the thigh, to extend and rotate it outwards; it can also act on the capsular ligament in the same manner as the glutæus minimus. Within the pelvis this muscle lies on the sacrum, and is covered by the hypogastric vessels, the sciatic plexus of nerves, and the rectum; the sciatic nerve often perforates it near its lower margin; on the dorsum of the pelvis it is covered by the glutæus maximus, and is parallel to but not covered by the glutæus medius; it adheres to the capsular ligament, and is superior to the gemini, from which it is separated by the sciatic nerves and vessels; it divides the sciatic notch into two parts, through the superior, pass the glutæal vessels and nerves, through the inferior the sciatic and pudic vessels, the sciatic nerve, and several smaller branches of the sacral plexus of nerves. To expose the following five small rotator muscles of the hip joint, draw to either side the great sciatic nerve, and remove the surrounding loose cellular tissue.

5, 6. Gemelli, two small muscles inferior to the last, behind the ilio-femoral articulation, and between the ischium and the trochanter; the superior small, sometimes absent, *arises* narrow and fleshy from the spine of the ischium: the fibres pass outwards above the tendon of the obturator internus, and are *inserted* with it into the upper part of the digital fossa of the great trochanter. Inferior *arises* also fleshy, from the upper part of the tuber ischii, and from the great sciatic ligament, the fibres run parallel to the former, and are also *inserted* into the digital fossa. *Use*, to rotate the thigh outwards, also to abduct it, to strengthen the capsular ligament, and to confine the obturator tendon in its situation. These muscles are concealed by the glutæus maximus and the sciatic nerve; are placed between the pyriformis and quadratus femoris muscles: they form a sort of sheath around the tendon of the obturator internus, and adhere to its edges, and appear as portions of this muscle added to it as it escapes from the pelvis: the inferior is the larger of the two; the superior is inserted between the pyriformis and the obturator internus, and the inferior between the tendons of the obturator internus and externus: they both adhere to the capsular ligament.

7. Obturator Internus is situated partly within the pelvis and partly behind the ilio-femoral articulation; somewhat triangular, the base within the pelvis, the apex at the great trochanter, *arises* by aponeurotic and fleshy fibres

within the pelvis from the superior or pelvic surface of the obturator or thyroid ligament, and from all the circumference of the foramen of that name, except at the upper part, where the obturator nerve and vessels pass through; beneath these a ligamentous arch is extended, and from this some fibres of this muscle proceed; it also arises from the pubis internally, from the ischium inferiorly, and from the thin but strong fascia of the same name which covers it, and separates it from the levator ani muscle; the fibres descend obliquely outwards and backwards, converging towards the lesser sciatic notch, which is between the spine and the tuberosity of the ischium; the fibres here end in a flat tendon, which, turning outwards, winds round the cartilaginous pully-like surface which the ischium presents; a loose bursa, and one, in general containing a quantity of synovia, is interposed between it and the bone; the tendon now runs outwards on the dorsum of the pelvis, between the gemini, and is *inserted* into the digital fossa of the great trochanter. *Use*, to abduct and rotate the thigh outwards; it may also act on the capsular ligament. This muscle within the pelvis is covered by the peritoneum, the pelvic fascia, levator ani muscle, and by a strong aponeurosis, the obturator fascia, which serves to give origin to some fibres both of this and of the levator ani muscles, between which it is interposed; it is the external layer of the pelvic fascia, adheres superiorly to the ilium and pubis, and inserted inferiorly into the great sciatic ligament, into the tuberosity and ramus of the ischium, also into the ramus of the pubis, and is continuous with the triangular ligament of the urethra; it is closely connected to this muscle; inferiorly the internal pudic nerve and vessels partly intervene, and are partly inclosed in the tissue itself (pages 260, 269). As the obturator tendon is passing through the sciatic notch, its deep surface is divided into four or five distinct tendons, which are lined by the synovial membrane, and connected to each other like so many plaits or folds; the pudic vessels lie external to the tendon in this situation; the continuation of the tendon to its insertion has the same relations as the gemini muscles.

8. Quadratus Femoris, *arises* by fleshy and aponeurotic fibres from the external surface of the tuber ischii, anterior to the tendon of the semi-membranosus; the fibres pass transversely outwards, and are *inserted* tendinous and fleshy into the inferior and posterior part of the great trochanter, and into the posterior inter-trochanteric line. *Use*, to adduct and rotate the thigh outwards: this muscle is covered by the glutæus maximus and sciatic nerve; its origin is also concealed by the hamstrings; it is parallel to and between the gemini and the adductor magnus; its lower border is overlapped by the latter; it covers the obturator externus, the lesser trochanter, and the insertion of the psoas and iliacus. Divide this muscle, and a little dissection will expose the following, particularly if the gracilis, adductor, and pectinæus muscles have been previously removed.

9. Obturator Externus, situated at the superior, posterior, and internal part of the thigh, somewhat triangular or pyramidal, the base towards the pubis, the apex at the trochanter; *arises* fleshy from the inferior surface of the thyroid or obturator ligament, and from the surrounding surface of the pubis and ischium, the fibres descend obliquely outwards and backwards behind the neck of the femur, in a sort of notch or grooved pulley between the tuber ischii and the edge of the acetabulum; here they end in a strong tendon, which ascends a little behind the neck of the femur, then runs directly outwards along the inferior gemellus, and, adhering to the capsular ligament, is *inserted* into the lower part of the digital fossa. *Use*, to adduct the thigh, and to rotate it outwards; it also supports and strengthens the inferior and posterior part of the ilio-femoral articulation, particularly in abduction of the thigh. This muscle is placed in a very deep situation, being covered anteriorly and inferiorly, by the adductor brevis and pectinæus, also by the obtu-

rator nerve and vessels, internally by the adductor muscles, externally by the joint, and posteriorly by the quadratus femoris and glutæus maximus.

The several small muscles just described, in addition to their individual actions, effect the common purpose of strengthening the ilio-femoral articulation. The capsular ligament of this joint is covered anteriorly by the rectus, psoas, and iliacus; internally by the pectinæus and obturator externus; externally by the tendon of the rectus, the glutæus minimus and medius; posteriorly by the pyriform, gemini, obturator tendons, quadratus femoris, and glutæus maximus; and inferiorly by the tendon of the obturator externus. Many of these muscles, like the small capsular muscles of the shoulder-joint, guard against dislocation in the different motions of the limb, and also serve to protect the capsular ligament by drawing it out of the angle which is formed between the acetabulum and the neck of the femur in the rotatory motions of the thigh; in the extended state of the limb, they chiefly act as rotators outwards, but in its flexed state they are abductors; when standing on one leg, which thus becomes fixed, they can rotate the pelvis and the trunk to the opposite side.

In dissecting the foregoing muscles, several vessels and nerves must have been remarked; the former are derived from the hypogastric or internal iliac vessels; the latter from the sacral plexus of nerves; the arteries are the glutæal, sciatic, and pudic. The *glutæal* artery escapes through the upper part of the sciatic notch, above the pyriform muscle, and immediately divides into several branches; these are distributed to the three glutæi muscles. The *sciatic artery* passes out of the pelvis through the lower part of the great sciatic notch, below the pyriformis; its principal branches descend between the tuber ischii and the great trochanter, and are lost in the surrounding muscles. The *pudic artery* escapes from the pelvis along with the last described vessel; it soon, however, re-enters the cavity through the lesser sciatic notch, and pursues its course forwards and inwards towards the perinæum and pubis, lying at first on the internal surface of the obturator internus, and afterwards on the rami of the ischium and pubis; its branches are distributed to the external organs of generation, and to the muscles in the perinæum. (*See* Anatomy of the Vascular System.) Each of these arteries has its corresponding vein, which takes a similar course, and terminates in the internal iliac vein. The nerves which are found in this situation are the superior and inferior glutæal, the posterior cutaneous, the pudic, the great and lesser sciatic; these are all branches of the sacral plexus, except the *superior glutæal nerve*, which is a branch of the lumbo-sacral, it accompanies the glutæal artery, and is distributed principally to the glutæus medius and minimus muscles. The *inferior glutæal nerve* escapes below the pyriform muscle, and is distributed principally to the glutæus maximus. The *inferior* or *lesser sciatic nerve* accompanies the last through the sciatic notch, descends obliquely inwards round the tuber ischii, and is distributed to the surrounding muscles and integuments. The *posterior cutaneous nerve* also passes through the lower part of the great sciatic notch, descends beneath the glutæus maximus, and then, becoming cutaneous, divides into several long branches, which may be traced along the posterior surface of the thigh, even to the leg, where in general they will be found to communicate with the posterior cutaneous nerves of that region. The *pudic nerves* take the same course as the pudic artery, and terminate in corresponding branches. The *great sciatic* or *posterior crural nerve* is the largest nerve in the body; it passes out of the pelvis below, but often through the pyriform muscle; descends behind the hip-joint in the fossa between the trochanter and tuber ischii, covered by the glutæus maximus, and passing over the gemini, obturator, and quadratus muscles; its course along the back of the thigh, and its branches, shall be considered after the dissection of the following muscles.

SECTION V.

DISSECTION OF THE MUSCLES ON THE BACK PART OF THE THIGH.

The fascia in this situation has been already noticed; the muscles are only three in number, and are commonly called hamstrings; the semi-tendinosus and semi-membranosus form the inner, the biceps the outer hamstring.

Biceps Flexor Cruris consists of a long and short head: the long head *arises* from the outer and back part of the tuber ischii and rather above it, in common with the semi-tendinosus; this descends obliquely outwards, and soon ends in a thick fleshy belly; about the inferior third of the thigh it joins, at an acute angle, the short head, which *arises* fleshy from the linea aspera, between the vastus externus and the adductors, commencing below the insertion of the glutæus maximus, and continuing to within two inches of the external condyle; here the muscle ends in a strong tendon, which descends at first behind the knee, then turns forwards and outwards towards the head of the fibula, into which it is *inserted;* the tendon is here divided in general by the external lateral ligament into two fasciculi, the superficial of which, in addition to its attachment to the head of the fibula, is also inserted into the fascia of the leg; and the deep fasciculus, which is also inserted into the fibula, sends some fibres to the head of the tibia. *Use*, to flex the knee-joint, also, by its long head, to extend the thigh and rotate the whole limb outwards; the long head can also fix the pelvis, prevent it and the trunk from bending forwards on the head of the femur, raise the body when bent, and maintain the erect posture. The superior fifth of this muscle is concealed by the glutæus maximus, the remainder is covered by the integuments and fascia, and descends between the vastus externus and semi-tendinosus, forming the outer hamstring; the long head passes over the semi-membranosus, the sciatic nerve, and the triceps muscles; it also conceals the short head: inferiorly the biceps passes over the external articular vessels and the external head of the gastrocnemius muscle.

2. Semi-tendinosus, large, flat, and fleshy above, round and tendinous below, *arises* by fleshy fibres from the tuberosity of the ischium in common with the long head of the biceps, also from the inner or anterior edge of the tendon of the latter for about three inches; it descends obliquely inwards, and about four inches above the knee it ends in a long round tendon, which, passing behind the head of the tibia, is then reflected forwards between the tendon of the semi-membranosus and the internal head of the gastrocnemius, and is *inserted* into the anterior angle of the tibia below its tubercle, inferior and posterior to the tendons of the gracilis and sartorius, to which it is connected: from the convex edge of the tendon an aponeurosis is given off, which joins the fascia of the leg. *Use*, to flex the knee and rotate the leg inwards, to extend the thigh, to support the pelvis, and prevent the trunk bending forwards. This muscle is covered superiorly by the glutæus maximus; the rest of its course is superficial; a transverse aponeurotic line usually intersects it about its centre.

3. Semi-membranosus, beneath the semi-tendinosus, flat and aponeurotic superiorly, thick and fleshy in the middle, round and tendinous below; *arises* by a flat tendon from the upper and outer part of the tuber ischii; this descends obliquely inwards, ends in a fleshy belly, which retains the muscular structure lower down than either of the former muscles; a little above the knee it ends in a round tendon, which passes behind the internal condyle, and divides into three processes, one of which passes outwards, another downwards, and a third

forwards; the first is a broad aponeurosis, which ascends obliquely outwards, beneath the heads of the gastrocnemius muscle, over the back part of the knee-joint, and is *inserted* into the external condyle of the femur; this aponeurosis has been termed the *posterior ligament* of the knee joint, or the *ligament of Winslow;* the second is a strong and broad fascia, which descends over the popliteus muscle, and is inserted into the posterior part of the heads of the tibia and fibula, and is also continuous with the deep fascia of the leg; the third process appears the continuation of the tendon, turns forwards beneath the internal lateral ligament, round the head of the tibia, into which it is *inserted. Use*, to extend the thigh on the pelvis, and to support the latter on the thigh, to flex the knee and to rotate the leg inwards; it also strengthens the back part of the knee, and can draw the synovial membrane out of the angle of the joint. This muscle, at its origin, lies external to the other hamstrings; covered at first by the semi-tendinosus, biceps, and glutæus maximus, inferiorly it is superficial; above it passes over the quadratus femoris and adductor magnus muscles; below it overlaps the popliteal vessels, and the internal head of the gastrocnemius, from which last it is separated by a bursa; the sciatic nerve is on its outer, the gracilis on its inner side.

The arteries which are met with in the dissection of these muscles are branches of the sciatic, circumflex, perforating, and articular; the numerous ramifications of these vessels are distributed to the hamstring and adductor muscles, and are accompanied by their corresponding veins: the principal nerve in this situation is the *great sciatic;* from the back part of the hip joint, this large nerve descends along the back of the thigh to the upper part of the popliteal space. where it divides into the peronæal and posterior tibial nerves; in this course it is covered at first by the glutæus maximus, afterwards by the biceps and semi-tendinosus, and inferiorly by the integuments and fascia; having passed over the quadratus femoris and the other small muscles at the back of the hip-joint, it next lies on the adductor magnus, and inferiorly on a quantity of adipose substance. The sciatic nerve gives off several cutaneous and muscular filaments, in addition to its two terminating branches, the peronæal and the posterior tibial; the *peronæal nerve* takes the course of the biceps tendon towards the head of the fibula, where it divides into several branches which are distributed to the integuments and muscles of the outer and forepart of the leg, as will be described in the dissection of that region. The *posterior tibial nerve* accompanies the popliteal vessels through the space of that name, which space the student should next examine.

The *popliteal space* is situated behind the knee-joint, extending upwards for about one-fourth of the thigh, and downwards for about one-sixth of the leg; it is somewhat oval, is bounded internally by the inner hamstring, and the internal head of the gastrocnemius; externally by the biceps, external head of the gastrocnemius, and plantaris; it is covered by the integuments and by a strong fascia, which, derived from the fascia lata, is strengthened by adhering to the condyles of the femur, and to the adjoining tendons; this fascia serves to approximate the sides of this region, and thus to give to it a considerable depth. The popliteal space is bounded before by the flat surface of the femur, by the back part of the joint covered by the ligament of Winslow, by the head of the tibia, and by the popliteus muscle and its fascia. In this region are contained the terminating branches of the sciatic nerve, the popliteal artery and vein, with their branches, also some lymphatic glands and much adipose substance. The nerves are superficial and external to the vessels, that is, nearer to the biceps; the vessels are close to the bone, and near to the semi-membranosus muscle, the vein being superficial, and a little to the outer side of the artery; two or three lymphatic glands are connected to the latter; and a quantity of fat, which is of a peculiar soft consistence, intervenes between the nerve and vessels. The course of the peronæal nerve

has been already noticed. The *posterior tibial nerve* descends nearly vertically between the hamstring muscles and the heads of the gastrocnemius, and then runs beneath the solæus, and over the poplitæus; above it lies to the outer side of, and at some distance from, the artery, but below it is in close contact with it, and to its tibial or inner side; it then accompanies the posterior tibial vessels down the leg, and along the inner side of the heel, to the sole of the foot, in which course it shall be examined afterwards. In the ham this nerve sends off muscular branches, also the *posterior* or *external saphenus nerve*, which accompanies the posterior saphena vein along the back of the leg, towards the outer ankle, behind which it passes to the external and superior part of the foot, where it is distributed: this nerve is by some called "communicans tibialis." The *popliteal artery* descends obliquely outwards through this space, and at the lower edge of the poplitæus muscle divides into the anterior and posterior tibial arteries; in this course it sends off many muscular and five articular branches; the latter supply the ends of the bones and the synovial membrane of the knee joint. The *popliteal vein* accompanies the artery, lying superficial and somewhat external to it; it receives branches which correspond to those of the artery, and it is joined inferiorly by the lesser or posterior saphena vein. Next proceed to the dissection of the leg.

SECTION VI.

DISSECTION OF THE LEG.

Remove the integuments of the leg and foot; on the plantar surface of the latter they are always remarkably hard and thick, even in the fœtus, particularly beneath the heel and the first and last joints of the toes; in these situations, also, the subcutaneous fat has a peculiar granulated structure, being intersected by tendinous bands, which pass from the skin to the plantar fascia. Beneath the integuments of the leg we find two cutaneous veins, the internal and external saphena; the *internal saphena* is large and regular, and has numerous branches; it commences by small veins from the upper surface of the toes, and from the dorsum of the foot; these run towards the inner malleolus, and unite in one large vessel, which ascends along the inner side of the leg, receiving in its course numerous branches from the integuments; it then passes behind the inner condyle of the femur, and, ascending along the inner and anterior part of the thigh, terminates in the femoral vein about an inch and a half below Poupart's ligament. On the thigh this vein is accompanied by small nerves, which are derived from the lumbar plexus and from the anterior crural; along the leg the saphenus nerve, a branch of the anterior crural, is attached to it, and winds round it. The *posterior* or *external saphena vein* commences behind the external ankle from the junction of several small veins from the integuments of the heel and the sole of the foot; it ascends along the surface of the gastrocnemius muscle, accompanied by the communicans tibialis nerve. At the ham this vein in general joins the popliteal vein, but sometimes it here turns inwards and joins the internal saphena vein, with which it always communicates in its course along the leg. Several cutaneous nerves are distributed to the leg, namely, the internal saphenus from the anterior crural, the posterior saphenus or communicans tibialis from the posterior tibial, and several cutaneous branches from the peronæal and anterior tibial nerves, which perforate the fascia of the leg on its outer and anterior part, and are distributed to the integuments of the leg and foot.

The *fascia* of the leg is derived partly from the fascia lata of the thigh; it also receives additional fibres from the tendons around the knee joint, namely, the rectus and vasti anteriorly; the vastus externus and biceps externally; the sartorius, gracilis, and inner hamstring internally; it adheres to the head of the tibia and fibula, to the spine of the tibia, near its whole length, to the annular ligaments of the ankle joint, and to the malleoli; it can scarcely be said to exist on the anterior surface of the tibia, which is only covered by the skin and periosteum: it is stronger superiorly than inferiorly. Near the ankle it again increases in strength from its connection to the malleoli and to the annular ligaments; these are three in number, anterior, internal, and external. The *anterior annular ligament* is a little above the joint; it is somewhat square, and stronger externally than internally; in the latter situation it is attached to the malleolar process of the tibia and to the os naviculare; in the former to the external malleolus, and to the upper part of the os calcis; it consists of two layers, which, by separating and re-uniting, form three rings or sheaths for the tibialis anticus and the two extensor tendons; the anterior tibial vessels and nerves also pass beneath it. The *internal* is broader than the anterior; it is attached to the internal malleolus and to the os calcis, forms a sort of arch over the groove or canal in which the three flexor tendons and the plantar nerves and vessels run. The *external*, short and narrow, is attached to the end of the external malleolus and to the os calcis; it binds down the peronæal tendons. The fascia of the leg is thin posteriorly; near the heel it is indistinct; on either side it is connected to the sheaths of the tendons that pass round the malleoli; and on each side of the tendo Achillis it sends in a lamina to join the fascia which covers the deep muscles of the leg, and which will be noticed presently: it serves to confine the muscles in their situation, and to give origin to many of their fibres, to which, therefore, it adheres above, but not below; this last effect is further accomplished by intermuscular bands or septa, which pass in from the fascia, between the extensor and peronæi muscles, attached to the tibia, fibula, and interosseous ligament. From the anterior annular ligament a thin fascia is extended over the dorsum of the foot; that covering the sole of the foot, *the plantar fascia*, is remarkably strong; it *arises* from the extremity of the os calcis, narrow, but thick and strong; passes forwards, expands, and divides into three parts, which lie on different planes, and which, by sending in two processes, serve to separate the plantar muscles into three orders, the internal, middle, and external; the lateral portions are attached to the sides of the tarsus and metatarsus; the internal portion is the weakest: the middle division is the strongest, and on a plane inferior to the internal. As this middle portion expands beneath the plantar muscles, it is strengthened by transverse fibres, and near the base of the toes it divides into five fasciculi; these diverge, and opposite the head of each metatarsal bone subdivide into two fasciculi, which pass along the sides of the metatarso-phalangal articulations, and are *inserted* into the lateral ligaments of these joints, and into the sheaths of the flexor tendons; between these fasciculi the tendons pass, also the digital vessels and nerves of each toe. The plantar fascia possesses the same strength as ligamentous structure. *Use*, it serves to retain the arched form of the foot, and to protect the plantar muscles, vessels, and nerves, from pressure; it also gives attachment to several muscular fibres. The skin and areolar tissue are directly connected to the fascia of the leg and foot, so that no distinct superficial fascia exists between them. The muscles of the leg may be divided into anterior, external, and posterior.

SECTION VII.

DISSECTION OF THE MUSCLES ON THE ANTERIOR AND EXTERNAL PART OF THE LEG.

The muscles on the forepart of the leg are four in number, viz., the tibialis anticus, extensor pollicis, extensor communis, and peronæus tertius. The muscles on the outer side of the leg are the peronæus longus and brevis. Almost all these muscles are connected to each other superiorly, so that they cannot be perfectly separated from each other; they all adhere to and partly arise from the fascia of the leg; therefore, when exposed, they present a rough surface superiorly.

Fig. 61.*

1. Tibialis Anticus, on the outer side of and next the tibia, somewhat triangular, large and fleshy above, tendinous below, *arises* tendinous and fleshy from the outer part of the two superior thirds of the tibia, from the head of the fibula, from the inner half of the interosseous ligament, from the fascia of the leg, and from the intermuscular septa. The fibres descend obliquely inwards, end in a strong and flat tendon which crosses from the outer to the forepart of the tibia, runs through a distinct ring in the annular ligament, near the internal malleolus, passes forwards and inwards above the astragalus and naviculare, increases in breadth, and is *inserted* into the inner side of the great or internal cuneiform bone, also by a tendinous slip into the base of the first metatarsal bone, or that of the great toe. *Use,* to flex the ankle, to adduct the foot, and to raise its inner edge from the ground; to turn the toes inwards, also to support the leg when standing, and prevent it bending backwards. This muscle is superficial through its whole length; the tendon, at its insertion, is partly concealed by the abductor and flexor pollicis brevis; superiorly it is external to the tibia, inferiorly it is anterior to it: the extensor communis and extensor pollicis, the anterior tibial vessels and nerve are to its outer or fibular side; a small bursa separates its tendon from the upper part of the internal cuneiform bone; another bursa in general surrounds it as it is passing over the synovial membrane of the ankle joint.

2. Extensor Digitorum Longus *arises* tendinous and fleshy from the external part of the head of the tibia, from the head of the fibula, and from about three-fourths of this bone, from part of the interosseous ligament, from

* The muscles of the anterior and external part of the leg. 1. The superior extremity of the tibia. 2. A portion of the ligamentum patellæ. 3. The subcutaneous surface of the tibia. 4. The tibialis anticus muscle. 5. The extensor digitorum longus. 6. The extensor pollicis proprius. 7. The peronæus tertius. 8. The peronæus longus. 9. The peronæus brevis. 10. A portion of the solæus muscle. 11. Edge of the gastrocnemius muscle. 12. The external malleolus. 13. The anterior annular ligament of the tarsus. 14. The extensor digitorum brevis. 15. The tendo Achillis.

the fascia of the leg, and its intermuscular septa; the fibres descend obliquely inwards; a little below the middle of the leg they end in three flat tendons, which pass under the annular ligament through a ring common to these and to the peronæus tertius, and extend forwards over the dorsum of the foot, the internal of the three tendons here divides into two; the four tendons now extend along the dorsum of each of the four external toes (the great toe does not receive any), and are *inserted* into the last phalanx of each. *Use*, to extend the toes and flex the ankle. This muscle is superficial; superiorly, it lies between the tibialis anticus and peronæus longus, and is connected to both. In the middle of the leg it is between the extensor pollicis and peronæus brevis; on the dorsum of the foot its tendons cross at an acute angle those of the extensor brevis, which separate the former from the bones of the tarsus. Opposite each of the four metatarso-phalangal joints one of its tendons unites with the inner border of the corresponding deep or accessory tendon, and both expand into the dorsal aponeurosis of the toe. This, similar to that upon the fingers, covers the dorsum of the first phalanx, and receives additional fibres from the lumbricales and interossæi. Opposite the joints between the first and second phalanges these fibrous sheaths divide into three fasciculi; the middle is inserted into the base of the second phalanx, the lateral pass over the sides of the joint, then unite on the dorsum of the second phalanx, and are inserted into the base of the last.

3. Extensor Pollicis Proprius *arises* tendinous and fleshy from the inner edge of the middle third of the fibula, and from the interosseous ligament nearly as low down as the ankle; a few fibres also proceed from the lower part of the tibia; its origin seldom extends above the middle third of the leg; the fibres descend obliquely forwards to a tendon which passes beneath the annular ligament, then runs forwards over the astragalus, navicular, and cuneiforme internum; the tendon next passes over the first metatarsal bone, and is *inserted* by two tendinous fasciculi, one into the base of the first phalanx, which also gives off an expansion on either side, and the other into the base of the second or last phalanx of the great toe. *Use*, to extend the great toe and flex the ankle; it may also adduct the foot, and rotate it inwards, and both this and the former muscle may, from the obliquity of their course, turn the toes outwards, and slightly raise the inner border of the foot. The upper and middle portions of this muscle are overlapped and concealed by the tibialis anticus and extensor communis, between which muscles it is situated; its tendon is superficial; the anterior tibial nerve and vessels separate it from the tibialis anticus above, and from the extensor communis below; it lies on the fibula and interosseous ligament above; inferiorly it crosses over the tibial vessels, the synovial membrane of the ankle joint, and bones of the tarsus; on the foot it crosses superficially the extensor brevis, and is on the inner side of the dorsal artery of the foot.

4. Peronæus Tertius, or anticus, appears to be a portion of the extensor communis, and in some cases cannot be separated from it; it *arises* from the anterior surface of the lower half of the fibula; the fibres pass forwards to a tendon which descends, along with that of the extensor communis, beneath the annular ligament; it then passes forwards and outwards, and is *inserted* broad and thin into the base of the fifth metatarsal bone, and it frequently sends a band of fibres to join the fourth tendon of the extensor communis. *Use*, to extend the little toe, to flex the ankle, to abduct the foot and raise its outer edge. This muscle is sometimes wanting, an additional tendon from the extensor communis will then supply its place; it is superficial; on the foot it conceals the extensor brevis, which may be next examined.

Extensor Digitorum Brevis, is the only muscle situated on the upper surface of the foot; it *arises* tendinous and fleshy from the upper and anterior part of the os calcis, in front of the groove for the peronæus longus, also

from the cuboid bone, the astragalus, and the annular ligament; it forms a flat, fleshy belly, which passes forwards and inwards, divides into four fasciculi, which soon end in four tendons, of which the two internal are the strongest; the little toe does not receive any; these tendons are *inserted* thus: the first, or most internal, into the base of the first phalanx of the great toe, passing beneath its long extensor at an acute angle, and crosses the dorsal artery of the foot as it is about to sink between the first and second metatarsal bones; the three other tendons join the outer edge of the corresponding tendons of the extensor digitorum longus, and assist in forming the aponeurosis which covers the dorsum of each toe. *Use*, to extend the toes and rotate the anterior part of the foot outwards. This muscle is partly concealed by the tendons of the long extensor and peronæus tertius; it projects, however, behind and between them; the tendons cross the metatarsal bones and the interossei muscles, beneath and in a different direction to the long extensor tendons, and as their obliquity is contrary to that of the latter, the combined action of both is to extend the toes directly: as the extensor tendons run in a more direct manner from the wrist joint to their insertion, there is no obliquity to correct, therefore there is no analogous muscle to this on the dorsum of the hand.

The muscles on the outer part of the leg are the two peronæi.

1. Peronæus Longus, *arises* tendinous and fleshy around the head of the fibula, and from the adjacent surface of the tibia, from the upper half of the external angle of the fibula, from the fascia and intermuscular septa, the fibres descend obliquely backwards and outwards, end in a strong, flat tendon, which passes behind the external malleolus, through a groove in the lower end of the fibula, in which it is bound down by a strong aponeurosis, lined by a synovial membrane; it then passes forwards, downwards and inwards, through a similar groove in the os calcis and cuboid, in each of which it is secured by a synovial membrane, and a very strong fibrous sheath; in the cuboid groove it is much thickened, and generally has a sesamoid bone or cartilage developed in it; it next passes across the sole of the foot, above the plantar muscles, obliquely inwards and forwards, towards the metatarsal bone of the great toe, into the outer side of which, and of the adjacent sesamoid bone, it is *inserted;* also, into the internal cuneiform, and into the base of the second metatarsal bone. *Use*, to extend the ankle joint, turn the foot outwards, and raise its outer edge, also to press the great toe against the ground as in walking; in the leg this muscle is superficial, and is situated between the extensor communis anteriorly and the solæus and flexor pollicis posteriorly, separated from both by aponeurotic septa; in the sole of the foot it is above all the muscles there, and cannot be seen until these are removed.

2. Peronæus Brevis, *arises* fleshy from the outer and back part of the lower half of the fibula, and from the intermuscular septa; the fibres descend obliquely, end in a tendon which passes behind the external malleolus in the same groove as the peronæus longus; it then passes forwards through a distinct groove in the os calcis, above the peronæus longus, and is *inserted* into the base of the metatarsal bone of the little toe, and into the os cuboides. *Use*, similar to the last. This muscle *arises* between the extensor longus and peronæus longus, and descends between the peronæus tertius and the flexor pollicis longus, and partly concealed by the peronæus longus; it continues fleshy lower down than that, and projects on either side of its tendon; it is separated from the peronæus tertius by the external malleolus; in the groove in the latter it is beneath the long peronæal tendon, that is, nearer to the bone, but on the os calcis it is superior to it; an aponeurosis sometimes unites its insertion to that of the extensor tendon of the little toe. When the fibula is fractured near its malleolus, these two muscles, by raising the outer edge of the foot and turning its sole outwards, frequently dislocate the foot out-

wards, or the ankle, that is, the astragalus, inwards: in a sprain or twisting of the ankle, these two tendons sometimes burst their sheath, are displaced, and lie in front of the malleolus; their action is then somewhat changed, and they become flexors of the ankle as well as abductors of the foot.

In the dissection of the foregoing muscles we meet with the anterior tibial vessels and their branches; also the peronæal nerve and its divisions. The *anterior tibial artery* is a branch of the popliteal; it passes forwards between the solæus and popliteus, perforates the interosseous space, surrounded by some fibres of the tibialis posticus; it then descends obliquely inwards and forwards as far as the cleft between the first and second metatarsal bones; in its course down the leg it is placed at first between the tibialis anticus and extensor communis, in the middle of the leg between the former and the extensor pollicis, and inferiorly between the tendon of the latter and that of the extensor communis; above it lies on the interrosseous membrane, below it passes over the tibia, the synovial membrane of the ankle joint, the astragalus, navicular, and cuneiform bones, and beneath the annular ligament and the internal tendon of the extensor digitorum brevis; in the leg the anterior tibial artery sends off, first, the recurrent branch, which ascends on the outer and forepart of the head of the tibia, and meets the external articular arteries; second, in its course along the leg, several muscular branches; third, near the ankle, the two malleolar branches; of these, the external is the larger, and inosculates with a small artery (the anterior peronæal) which perforates the interosseous ligament about two inches above the ankle joint; on the tarsus, the anterior tibial artery, or, now called, dorsal artery of the foot, sends off the tarsal and metatarsal branches, which pass obliquely outwards, and supply the interossei muscles, the bones and joints of the tarsus and metatarsus; between the two first metatarsal bones the anterior tibial divides into the superior and inferior branch; the former supplies the integuments of the great toe; the latter passes deep towards the sole of the foot, and joins the external plantar artery; the anterior tibial artery is accompanied by two veins, which end in the popliteal vein. The *peronœal nerve* winds round the head of the fibula, perforates the peronæus longus, and divides into several branches; some of these supply the peronæal muscles, others the integuments on the outer and forepart of the leg and foot; and the continuation of the peronæal nerve passes obliquely forwards and downwards, accompanies the anterior tibial artery, lying in general superficial, and to its fibular side.

SECTION VIII.

DISSECTION OF THE MUSCLES ON THE BACK OF THE LEG.

These muscles are seven in number, and may be divided into a superficial and a deep layer; the former consists of three, the gastrocnemius, solæus, and plantaris; the latter of four, the tibialis posticus, flexor pollicis longus, flexor digitorum communis, and popliteus. The cutaneous nerves and veins, and the fascia, have been already noticed.

1. Gastrocnemius, large and thick, tendinous below, fleshy and aponeurotic above, and divided into two heads; both are somewhat oval, convex behind, flat before; the internal longer and larger than the external; *arises* from a digital depression on the upper and back part of the internal condyle of the femur, and fleshy from the oblique ridge above it, behind the insertion of the adductor magnus, and on a plane posterior to the external head, which is not so long or so large, and which *arises* in the same manner above

the external condyle from a pit above the groove for the popliteus tendon. The fibres of each descend converging, and form two fleshy bellies, which unite a little below the knee in a middle tendinous line, and form the calf of the leg; the inner head constituting the larger portion. About the middle of the limb the muscle ends in a broad and flat tendon, which gradually unites with that of the solæus underneath, and both form the strong tendon called *tendo Achillis*, which is *inserted* into the lower and back part of the os calcis. *Use*, to extend the ankle joint, and thus, by raising the heel from the ground, to lift the weight of the whole body, and throw it forwards on the toes, as in progression; to flex the knee joint, also to secure this articulation against displacement, by preventing the condyles of the femur slipping backwards off those of the tibia. This great muscle is superficial, a small portion of its internal head is overlapped by the semi-membranosus; its deep surface is more aponeurotic than its superficial; the lower angle of the popliteal space separates its two heads; in this angle the popliteal vessels, posterior tibial nerve, and plantaris muscle, are contained; a bursa is placed between each head and the condyle of the femur, which it covers; a sesamoid bone or tubercle often exists in each, particularly the outer; these support the condyles like strong capsules: the external head conceals the tendon of the popliteus; the internal covers the deep processes of the semi-membranosus tendon and an intervening bursa, also the insertion of the popliteus: the gastrocnemius covers the greater part of the solæus, therefore to examine the latter detach the heads of the former from the condyles, and separate it from the solæus to within two or three inches of the heel, or cut the muscle transversely about the centre, and raise the upper portion, whereby its structure will be seen. The plantaris muscle is now also exposed.

2. Plantaris *arises* fleshy from the back part of the femur, above the external condyle, and from the posterior ligament of the knee; it is connected to the external head of the gastrocnemius, forms a small, pyramidal, fleshy belly, which descends obliquely inwards, crosses the popliteal vessels, and ends in a flat tendon (the longest in the body), which descends between the gastrocnemius and solæus. When the tendons of these muscles are about to unite, that of the plantaris becomes superficial, and descends along the inner side of the tendo Achillis to the heel, and is *inserted* into the posterior part of the os calcis, a little anterior to the tendo Achillis; it has also some connection to the plantar fascia and subcutaneous tissue. *Use*, to extend the foot, and turn it inwards, also to make tense the fascia, and to flex the knee; its origin is partly concealed by the external head of the gastrocnemius; its tendon also is at first covered by this muscle, but inferiorly it is superficial. This muscle is sometimes wanting; it may probably be considered as rudimentary rather than essential; the tendon is often found so long and loose, and even coiled, that we can scarcely suppose the muscle had been accustomed to act, at least with any force. In most animals it is better developed in proportion than in man; in the quadrumana it acts as a tensor of the plantar fascia, and in quadrupeds it answers to the perforated flexor of the toes; but in man the great muscles of the calf preponderate over all other animals, their superior development being obviously in relation to the erect position he is destined to enjoy. In some instances the plantaris tendon is short and tense; in such the muscle may rupture it, an accident which has been noticed by surgical writers.

3. Solæus, of an oval and flattened figure, consists superiorly of two heads, which are not so distinct from each other as those of the gastrocnemius; the external is longer and larger than the internal, and *arises* from the back part of the head and from the superior third of the fibula, behind the peronæus longus; the internal *arises* from the middle third of the tibia, commencing below the oblique insertion of the popliteus; the two heads are connected by a strong tendinous arch, beneath which pass the posterior tibial nerve and

vessels; all the fibres descend and form a large oval belly, which continues fleshy lower than the gastrocnemius. A tendon is formed first on its superficial surface, and is gradually united to that of the gastrocnemius to form the tendo Achillis. This strong tendon is broad and thin above, narrow and depressed in the middle, and round and thick below; it is composed of strong vertical fibres, which descend behind the os calcis, over a bursa, covering a cartilaginous impression on that bone, and is *inserted* into a rough surface below that. Occasionally a small bursa is also found between it and the skin. This muscle is almost entirely concealed by the gastrocnemius; a little below the middle of the leg, however, it projects on each side of the tendon of the latter, and forms the lower calf; it covers the deep-seated muscles, vessels, and nerves. *Use*, to assist the gastrocnemius in extending the ankle, but it cannot exert any influence on the knee-joint as that muscle does. When standing, the solæus supports the leg, and resists the tendency of the body to fall forwards, while the gastrocnemii strengthen the back part of the knee joint, press the condyles forwards, and resist their tendency to rotate backwards and upwards in the superficial tibial cavities; they can also flex the knee when the anterior extensors permit, but, as they are very close to the fulcrum, their action in this respect is feeble, whereas the combined actions of these two muscles, which may be considered as one powerful triceps or quadriceps extensor pedis, and which is the largest muscle in the body, are most powerful; they are the principal agents not only in maintaining the erect posture, but also in all locomotive exertions, such as walking, running, dancing, leaping, &c.; they are peculiarly and very favorably circumstanced for the exercise of power; the lever, whereby they act, is of the second order, the toes being the fulcrum at one end; the weight, which is the body, rests upon the astragalus in the ankle joint in the middle; and the power, which is at the other hand, is represented by the insertion of the tendo Achillis into a rough projection on the lower part of the os calcis, and which insertion is perpendicular to the lever. A violent action of these powerful muscles occasionally ruptures the tendo Achillis, or tears off a fragment of the os calcis.

Fig. 62.*

Detach the solæus from its origin, and the strong, deep fascia of the leg is exposed; this fascia is partly derived from the semi-membranosus and popliteus, and partly from the more superficial fascia of the leg; it adheres to the tibia and fibula, to the solæus, and to the deep muscles: inferiorly it is strong, and connected to the sheaths of the tendons that pass behind the malleoli, and to the lateral annular ligaments of the ankle; raise it, and clean the four following muscles: popliteus, two long flexors of the toes, and the tibialis posticus; the first is confined to the region of the knee, or ham,

* The deep layer of muscles on the back of the leg. 1. The lower extremity of the femur. 2. The internal condyle. 3. The external condyle of the same bone. 4. The tendon of the semi-membranosus muscle. 5. The ligamentum posticum of Winslow. 6. The external lateral ligament of the knee-joint. 7. The popliteus muscle. 8. The flexor digitorum longus. 9. A portion of the tibialis posticus. 10. The flexor pollicis longus. 11. The head of the fibula. 12. The peronæus longus. 13. The tendon of the peronæus brevis passing to its insertion into the posterior extremity of the fifth metatarsal bone. 14. The os calcis. 15. The tendon of the tibialis posticus proceeding to its insertion into the inferior tuberosity of the navicular bone and internal cuneiform bone. 16. The tendon of the flexor digitorum longus. 17. The tendon of the flexor pollicis longus. 18. The tendon of the peronæus longus, traversing obliquely the sole of the foot to its insertion into the base of the metatarsal bone of the great toe, &c.

but the other three extend along the leg into the foot, and are all reflected or bent round the inner ankle, vertical in the leg, horizontal in the foot.

4. Popliteus, situated obliquely at the upper and back part of the leg, bound down by a strong fascia, behind the knee, above the other muscles in this region, flat and triangular; *arises* by a round and very strong tendon from a depression on the external surface of the outer condyle, below the origin of the outer head of the gastrocnemius and of the external lateral ligament; descends obliquely inwards and backwards, above the head of the fibula, and along the external semilunar cartilage, to which it is connected by the synovial membrane of the knee, and by a few tendinous fibres; becomes broad and fleshy, and is *inserted* into a flat, triangular surface, which occupies the superior fifth of the posterior surface of the tibia. *Use*, to bend the knee, and, when bent, to twist the foot and toes inwards; it may also assist, when the limb is extended, in rotating the knee outwards: it supports the external semilunar cartilage, and moves it slightly, so as to adapt its situation to the external condyle of the femur in the rotatory motions of the joint; the popliteus is covered by the two heads of the gastrocnemius, the plantaris, the external lateral ligament, and the popliteal nerve and vessels; it is superior to the inner head of the solæus, and passes over the tibio-fibular articulation and the back part of the tibia; it is nearly parallel to the upper part of the plantaris; the tendon is nearly surrounded by the synovial membrane of the knee, but is external to its cavity; it also adheres to the membrane of the tibio-peronæal joint, and sometimes the *cul de sac*, which attends it from the former articulation, communicates with the latter so as to constitute one synovial membrane to these two articulations, as is normally the case in many animals.

5. Flexor Digitorum Perforans, longus or communis, broader in the centre than at either end; *arises* fleshy from the posterior flat surface of the tibia, commencing below the popliteus, and extending to within two or three inches of the ankle, also from the fascia and intermuscular septa. The fibres descend obliquely inwards to a tendon which passes behind the internal malleolus, in a groove in the tibia lubricated by a bursa, and in which it is confined, along with the tendon of the tibialis posticus, by the internal annular ligament, separated, however, from that tendon by a ligamentous septum; each tendon also has a distinct synovial sac; it then turns forwards and a little outwards into the sole of the foot, still confined in a bony groove, first in the astragalus, and then in the os calcis: in the sole of the foot it lies beneath the tendon of the flexor pollicis, and is connected to it by a tendinous slip. About the centre of this region it expands and receives the insertion of the accessory muscle; it then divides into four tendons, which pass to the four outer toes, and opposite the first phalanx each tendon enters a strong fibrous sheath, which is lined by synovial membrane. This sheath continues as far as the extremity of the second phalanx, and contains also the corresponding tendon of the flexor digitorum brevis. Opposite the base of the second phalanx each of the last-named tendons is slit for the transmission of the long flexor tendon, which continues to run forwards to be *inserted* into the base of the last phalanx of each of the four lesser toes. *Use*, to flex all the phalanges of the toes, also the metatarsus; to extend the ankle, and to steady the leg on the foot as when standing; the accessory muscle assists it in flexing the toes, and, by correcting its obliquity, diminishes its tendency to invert the foot when extending the ankle joint. This muscle is the most internal in this layer; in the leg it is covered by the superficial muscles, the deep fascia, and the tibial vessels; it overlaps the tibialis posticus, and is on the inner or tibial side of the flexor pollicis. A little above the inner ankle the tendon of the tibialis posticus crosses above that of the flexor communis, that is, nearer to the tibia. In the sole of the foot its direction is horizontal; it is there superior to the

flexor brevis and abductor pollicis, inferior to the transversalis pedis and peronæus longus tendon. The lumbricales muscles arise from the tibial or inner sides of its tendons.

6. Tibialis Posticus, larger above than below, *arises* from the posterior and internal part of the fibula, from the upper part of the tibia, from almost the entire length of the interosseous ligament, and from intermuscular septa. The fibres descend and end in a strong tendon, which passes, along with that of the last muscle, behind the internal ankle, crosess above that tendon, and then proceeds obliquely forwards and inwards, and is *inserted* into a tuberosity on the inferior and internal part of the os naviculare, and into the internal cuneiform bone ; it also sends some fibres to the cuboid and to the second and third metatarsal bones. A small bony or cartilaginous tubercle is often found in this tendon, near to its insertion, beneath the head of the astragalus ; it also glides over a small bursa in this situation. *Use*, to extend the ankle and to raise the inner edge of the foot from the ground. The upper end of this muscle is notched by the anterior tibial vessels ; a few of its fibres accompany these vessels through the interosseous space, and are attached to the anterior surface of the ligament. In its course down the leg it is covered by the solæus, and overlapped by the flexor communis and flexor pollicis ; it covers the tibia, fibula, and interosseous ligament, winds round the deltoid or internal lateral ligament, passes beneath the head of the astragalus, and supports that strong fibro-cartilage, which extends from the os calcis to the os naviculare, beneath the head of the astragalus, which elastic substance supports a great portion of the weight of the body in standing, and in progression.

7. Flexor Pollicis Longus is the most superficial and external in this plane ; *arises* from the two inferior thirds of the fibula, from the fascia covering the tibialis posticus, from intermuscular septa, and, inferiorly, from a small portion of the interosseous membrane ; the fleshy fibres descend obliquely inwards to a tendon which passes behind the internal malleolus through a groove, first in the tibia and next in the astragalus. Entering the sole of the foot, this tendon crosses above the flexor communis, and is connected to it by a strong tendinous slip ; it then proceeds forwards and inwards, between the two portions of the flexor pollicis brevis, enters a strong tendinous sheath between the sesamoid bones, and is *inserted* into the base of the last phalanx of the great toe. *Use*, to flex this toe, to extend the ankle and adduct the foot, but in a much less degree than the common flexor. It lies to the fibular side of the tibialis posticus, between it and the peronæi muscles. The peronæal vessels are inclosed between its fibular and its internal aponeurotic origin. As it passes behind the internal ankle it is about half an inch behind the tendons of the tibialis posticus and the flexor communis, and is separated from these by the posterior tibial nerve and vessels.

SECTION IX.

DISSECTION OF THE MUSCLES OF THE FOOT.

There is but one muscle on the dorsum or on the upper surface of the foot, the extensor digitorum brevis, which has been already examined, as being an appendix to or continuation of the long extensors of the toes, which arise from the bones of the leg ; the dorsal or superior interossei mucles do not properly belong to this region, and may be examined with the inferior set. The integuments and fascia in the sole of the foot have been already

Fig. 63.*

noticed. The muscles here are very numerous: they may be divided into four laminæ; these are tolerably distinct about the middle of this region, but at either side this arrangement is rather artificial; the two intermuscular processes of the plantar fascia also divide these laminæ into three compartments, an internal, a middle, and an external. The muscles of the first, or superficial layer, are the abductor pollicis, flexor digitorum brevis, and abductor minimi digiti: in the second layer are the long flexor tendons, the accessory muscle, and the lumbricales. The third layer consists of the flexor pollicis brevis, adductor pollicis, transversalis pedis, and flexor minimi digiti. In the fourth layer are the interossei muscles, and the tendon of the peronæus longus.

Abductor Pollicis *arises* tendinous and fleshy from the lower and inner part of the os calcis, from the internal annular ligament, the plantar aponeurosis, and internal intermuscular septum; the fibres pass forwards and inwards, and are *inserted* tendinous into the internal sesamoid bone, and into the internal side of the base of the first phalanx of the great toe. *Use,* to separate the great toe from the others; it can also flex it. This muscle is by some writers called the adductor pollicis, its action being then referred to the mesial line of the body; it is the most internal of the plantar muscles, and is superficial; the fascia covering it is very thin; the long tendons and plantar vessels and nerves pass between its heads or origins from the internal malleolar region into the sole of the foot; a septum from the plantar fascia alone separates its outer border from the following muscle.

Flexor Digitorum Brevis Perforatus, short, thick, and narrow behind; *arises* from the inferior and rather from the internal part of the os calcis, from the internal annular ligament, the plantar aponeurosis, and intermuscular septa; it forms a fleshy mass, which, passing forwards, divides about the middle of the foot into four delicate muscles, which soon end in tendons; these accompany the flexor longus communis into the tendinous and synovial sheaths, beneath the phalanges of the four outer toes: each tendon is slit opposite the base of the second phalanx, and, having transmitted the long flexor tendon, is then folded out on the inferior surface of the second phalanx, and again bifurcates close to the bone, and is *inserted* into its lateral borders, above the long flexor tendon, having been previously beneath it. *Use,* to assist the long flexor, to strengthen the plantar fascia, and to preserve the arch of the foot. This muscle is immediately above the strong central portion of the plantar fascia, from which a considerable portion of it arises, therefore it always presents a rough surface when dissected; it is beneath the plantar vessels and nerves, the long flexor tendons, the accessory muscles, and the lumbricales; it is joined to the abductor pollicis posteriorly, but anteriorly is separated from it by the tendon of the flexor pollicis longus; the fourth, or the external of its tendons, or that for the little toe, is sometimes wanting. This muscle is analogous to the flexor sublimis of the fingers, but much smaller, and wants the vertical portion.

Abductor Minimi Digiti is situated along the outer edge of the foot, *arises*

* The first or superficial, and part of the second layer of muscles in the sole of the foot, the plantar fascia having been removed. 1. The inferior surface of the os calcis. 2. The abductor pollicis. 3. The flexor digitorum brevis perforatus 4. The abductor minimi digiti. 5. The tendon of the flexor pollicis longus. 6. 6. 6. 6. The lumbricales. 7. One of the tendons of the flexor digitorum longus passing through the slit in the corresponding tendon of the flexor digitorum brevis.

tendinous and fleshy from the outer side of the os calcis, and from a strong ligament which extends from this to the fifth metatarsal bone, also from the bone of the latter, from the plantar fascia, and its external intermuscular septum; *inserted* tendinous into the outer side of the base of the first phalanx of the little toe, and into the adjoining surface of the metatarsal bone. *Use*, to separate the little toe from the others, and to flex it. This muscle is also superficial; the fascia covering it is very strong; it is the most external of the muscles in this region.

Detach this first layer of muscles from their posterior attachments, and throw them forwards towards the toes; the tendons of the flexor pollicis and communis are now exposed, also the accessory muscle and the lumbricales; all these constitute the second layer of the plantar muscles, and which is partially concealed by the first.

The tendon of the flexor longus digitorum communis is seen passing from the inner side of the os calcis to the middle of the plantar region, where it divides into its four tendons, which have been already described as entering the sheaths on the interior surface of the four outer toes, passing through the slits in the tendons of the flexor brevis, and then inserted into the last phalanx of each toe. The tendon of the flexor pollicis longus is now also seen passing above the former, to which it is united by a tendinous fasciculus, and then proceeding forwards to its insertion to the base of the great toe.

Fig. 64.*

Musculus Accessorius, or flexor digitorum accessorius, square, flat, and fleshy; *arises* bifurcated, fleshy and tendinous from the inferior and lateral borders of the os calcis, forms a flat and somewhat square, fleshy belly, which, proceeding forwards, is *inserted* into the upper and outer part of the tendon of the flexor digitorum longus, just before it divides; an expansion from the flexor pollicis longus also joins it, and extends to the flexor communis. *Use*, to assist the long flexor, and to counteract its obliquity by pulling it directly towards the heel. This muscle lies above the flexor digitorum brevis and the plantar vessels and nerves, and beneath the os calcis and the calceo-cuboid ligaments. There is no analogous muscle to this in the hand, as there the flexor tendons pass directly over the centre of the carpus.

Lumbricales are four small muscles which *arise* tendinous and fleshy from the angles between the tendons of the flexor digitorum longus; there is none for the great toe: the first or the internal one is the largest. These four muscles proceed forwards along the internal edge of the long flexor tendons; each ends in a thin aponeurosis, which is *inserted* into the internal side of the first phalanx of the four lesser toes, and joins the tendinous expansion of the extensor tendons on the dorsum of the toes. *Use*, to adduct and to assist in flexing the four toes; they may also extend their second and last phalanges. These muscles are covered in the sole of the foot by the superficial layer, but emerge from beneath this and the plantar fascia in the interstices between the sheaths of the flexor tendons; their tendinous insertions are superficial, and are best seen on

* The second and part of third layer of muscles in the sole of the foot. 1. The inferior surface of the os calcis. 2. A portion of the inferior calcaneo-cuboid ligament. 3. The tendon of the flexor digitorum longus dividing into its four portions. 4. 4. The tendon of the flexor pollicis longus. 5. The musculus accessorius. 6. 6. 6. 6. The lumbricales muscles. 7. A portion of the flexor pollicis brevis. 8. Part of the flexor brevis minimi digiti.

the dorsum of the toes. They are analogous to the four lumbricales in the hand, which also arise from the deep or perforating flexors, and run along the radial side of each tendon, or that next the thumb, so in the foot they run along that side which corresponds to the great toe; hence, although they are described as running along the outer sides of the flexor tendons in the hand, and along the inner in the foot, yet still they are perfectly analogous, supposing the hand in the prone position, or the foot in the supine. Detach this second layer of muscles, and throw it also forwards towards the toes.

The third layer of the plantar muscles consists of the flexor pollicis brevis, adductor pollicis, transversalis pedis, and flexor minimi digiti.

Flexor Pollicis Brevis, narrow posteriorly, broad and notched anteriorly; *arises* by a strong tendon from the lower and anterior part of the os calcis, also from the cuboid and external cuneiform bone and their connecting ligaments; it forms a fleshy belly which is inseparably connected to the abductor and adductor pollicis; passes forwards and inwards, and divides into two short tendons; *inserted* into the sesamoid bones beneath the first phalanx of the great toe. *Use*, to flex the first joint of the great toe, also to approximate this toe to the others. This muscle forms a sort of sheath for the tendon of the flexor pollicis longus, and is analogous to the short flexor of the thumb.

Fig. 65.*

Adductor Pollicis is situated external to the last muscle, or more in the centre of the foot, is inseparably attached to it, and is the largest muscle in this plane; it arises tendinous and fleshy from the strong calcaneo-cuboid ligament, from the sheath of the peronæus longus, and from the base of the second, third, and fourth metatarsal bones; passes forwards and inwards, *inserted* along with the external portion of the last muscle into the external sesamoid bone. *Use*, to draw the great toe outwards towards the others, also to flex it, so as to bring it beneath them. By some this muscle is named the abductor pollicis, its action being then referred to the mesial line.

Transversalis Pedis *arises* by distinct, fleshy slips from the anterior extremities of the four external metatarsal bones. The fibres pass inwards and forwards, converging to the external sesamoid bone of the great toe, into which they are *inserted* along with the last described muscle. *Use*, to approximate the toes, and to contract the transverse arch of the foot. There is no analogous muscle in the hand, except the anterior transverse fibres of the adductor pollicis. Behind this muscle, and nearly parallel to it, the strong calcaneo-cuboid ligament is observed; also the tendon of the tibialis posticus dividing into several slips, which are inserted into the adjacent bones and ligaments.

Flexor Brevis Minimi Digiti *arises* tendinous and fleshy from the cuboid and fifth metatarsal bone, and from the sheath of the peronæus longus tendon; it passes forwards and outwards, and is *inserted* into the inner side of the base of the first phalanx of the little toe. *Use*, to flex and adduct this toe. This muscle is connected to the abductor minimi digiti; it fills up the

* The third and part of the fourth layer of muscles of the sole of the foot. 1. The inferior surface of the os calcis. 2. The inferior calcaneo-scaphoid ligament. 3. The inferior calcaneo-cuboid ligament. 4. The flexor pollicis brevis. 5. The adductor pollicis. 6. The transversalis pedis. 7. The flexor brevis minimi digiti. 8. 8. 8. The inferior interossei muscles. 9. The tendon of the peronæus longus, in its sheath, passing obliquely across the sole of the foot.

concavity of the fifth metatarsal bone. Detach these four muscles in this layer from the tarsus, and the fourth layer will come into view, namely, the tendon of the peronæus longus and interossei muscles; the former crosses the foot obliquely forwards and inwards from a deep groove in the cuboid, beneath the cuneiform and metatarsal bones, to be *inserted* into the internal cuneiform and into the base of the first and second metatarsal bones; in this course this strong round tendon is inclosed in a tendinous sheath, which is lined by synovial membrane, and is attached to the several projections of the adjoining bones. *Use*, to serve as a strong, transverse ligament in strengthening the tarsus and metatarsus in that direction. This course and connection of the tendon explain the action of the peronæus longus muscle, namely, to extend the ankle joint, to elevate the external side of the foot, to depress its internal side, and to turn the point of the foot outwards.

INTEROSSEI MUSCLES are seven in number; three are seen in the sole of the foot, and four on the dorsum; they fill up the interstices between the metatarsal bones: the three inferior are named *interossei interni*, or *inferiores*, and lie rather beneath or in the concavity of these bones than between them, the interosseous space being very narrow; they *arise* tendinous and fleshy from between the metatarsal bones of the four external toes, and are *inserted* tendinous into the inner side of the extensor tendon and of the base of the first phalanx of the three lesser toes. *Use*, they are all adductors of the toes, like the palmar interossei, that is, supposing the axis of the foot to be in the line of the second toe, and not, as in the hand, through the third or middle finger; they each arise from one metacarpal bone only, from its lower surface, and from the lower part of its inner side, that which looks towards the axis of the foot, and are inserted each into the inner side of the same toe; none of them are attached to the first and second toes, but the adductor pollicis might be considered as belonging to this group. The *first* is between the second and third metatarsal bones, *arises* chiefly from the inner side of the third, and is inserted into the inner side of the first phalanx of the same or the middle toe; this is the *adductor medii digiti*; the *second* is between the third and fourth metatarsal bones, *arises* chiefly from the inner side of the fourth, is *inserted* into the inner side of the first phalanx of the same toe, and is the *adductor quarti digiti;* the *third* is between the fourth and fifth metatarsal bones, *arises* from the fifth, and is *inserted* into the inner side of the little toe, and is the *adductor minimi digiti:* these three muscles might rather be called sub-interosseous muscles; they are so connected together as to appear at first as one fleshy mass; they are covered by an aponeurosis from the plantar, which separates them from the subjacent tendons and vessels.

The *interossei externi* or *superiores* are four in number, are larger than the last, and are seen on the dorsum or convex surface of the foot; like those on the hand, they are bicipital muscles, communicating branches between the dorsal and plantar vessels passing between their heads. *Use*, they are all abductors, that is, expand the toes, or separate them from the axis of the foot; the first or great toe is unaffected by them, it however has its proper abductor in the sole of the foot; the same may be said of the little or the fifth toe; the second toe or axis has one inserted into either side, which, if both act together will fix it, or they may alternately move it to either side, the third and fourth are inserted into the outer sides of the third and fourth toes, and are therefore abductors of both; all these tendons likewise join the expansion of the extensor tendons. The *first* is between the first and second metatarsal bones, and may be named the *internus digiti secundi;* it *arises* from the internal side of the second metatarsal bone, and by a distinct fasciculus from the outer side of the first; these two origins are separated by the deep branch of the anterior tibial artery, or the communicating branch between the dorsalis pedis and the external plantar; the fibres end in a tendon

which is *inserted* into the inner side of the base of the first phalanx of the second toe; it also joins the corresponding extensor tendon. *Use*, to approximate the second to the great toe. The *second, or externus digiti secundi*, is placed between the second and third metatarsal bones; *arises* from their opposite surfaces, but chiefly from that of the former; the fibres end in a tendon which is *inserted* into the outer side of the first phalanx of the second toe. *Use*, to separate the second from the great toe. The *third, or abductor digiti medii*, is placed between the third and fourth metatarsal bones, and *arises* from their opposite surfaces, but chiefly from that of the third; the fibres end in a tendon which is *inserted* into the outer side of the phalanx of the third toe. *Use*, to separate the third toe from the second. The *fourth, or abductor digiti quarti*, is situated between the fourth and fifth metatarsal bones; it *arises* from their opposite surfaces, and is *inserted* into the outer side of the first phalanx of the fourth toe from the three internal. All these muscles are covered by the long and short extensor tendons, and by a strong aponeurosis, which binds them down between the bones, and presses them towards the plantar surface; they conceal the inferior interossei, and are separated from them by a fine fascia derived from the plantar. Both sets of interossei muscles serve to strengthen the metatarsus, and to press the metatarsal bones together; they also serve to flex the first joint of the four outer toes, but may assist in extending their last phalanges; these muscles can exert no influence on the great toe; there is only one muscle between the two first metatarsal bones; between the others there are two, therefore there are four superior or dorsal interossei muscles, but three inferior; the latter are situated more in the concavity of each metatarsal bone than between these bones; the superior are stronger and more tendious than the inferior; and are only partially covered by the long and short extensor tendons.

In dissecting the muscles on the back of the leg, and those in the sole of the foot, we meet the posterior tibial vessels and nerve, and their principal branches. The posterior *tibial artery* is the larger branch of the popliteal; it descends obliquely inwards beneath the deep fascia and the superficial muscles, and over the tibialis posticus and flexor communis, to the fossa between the heel and inner ankle, it here ends in the two plantar arteries: in this course it gives off many muscular branches, also the *peronæal artery;* the latter arises from the tibial, about an inch below the poplitæus; it descends obliquely outwards along the back part of the fibula beneath the flexor pollicis longus; behind and a little above the outer ankle, it divides into the anterior and posterior peronæal arteries; the former perforates the interosseous space and joins the external malleolar artery; the latter descends between the external ankle and the heel, and is distributed to the ligaments and adipose substance in that region.

The two plantar branches of the posterior tibial artery are distributed to the muscles and integuments of the foot and toes; the *internal plantar* is the smaller of the two, it supplies the muscles along the inner side of the tarsus: the *external plantar*, the large branch, runs across the foot obliquely outwards, towards the fifth metatarsal bone, between the first and second layers of plantar muscles; from the little toe it next runs obliquely forwards and inwards, towards the first metatarsal bone, above the second layer of the plantar muscles, and between the first and second metatarsal bones it joins the deep branch of the anterior tibial artery, and thus forms the great plantar arch of arteries, from the convexity of which proceed the digital arteries, to supply the toes. (*See* Anatomy of the Vascular System.) The posterior tibial artery and its several branches are accompanied by corresponding veins, all of which end in the popliteal vein. The *posterior tibial nerve* is the principal branch of the sciatic, it accompanies the posterior tibial artery, at first lying to its tibial, afterwards to its fibular side; in this course it sends

off several small branches to the deep and superficial muscles of the leg, and between the heel and ankle it divides into the two plantar nerves, which take the course of the corresponding arteries. In this internal malleolar region, when the integuments, fascia, and internal annular ligaments are removed, we find the three tendons and the posterior tibial nerves and vessels to have the following relation to each other: the tibialis posticus and flexor communis tendons are bound close to the ankle; about half an inch behind these is the posterior tibial artery, accompained by two veins; the nerve is a little nearer to the heel; and the tendon of the flexor pollicis lies about half an inch nearer to the latter.

PART II.

ANATOMY OF THE VASCULAR SYSTEM.

UNDER THIS HEAD WE MAY CONSIDER THE ANATOMY OF THE ARTERIES, VEINS, AND ABSORBENTS.

CHAPTER I.

ANATOMY OF THE ARTERIES.

THE heart, the great central organ for regulating the circulation, propels the blood into the arterial tubes, which conduct this fluid through all parts of the system. Two large arteries spring from the heart, the pulmonary and the aorta; the former conveys from the right ventricle, the venous or impure blood through the lungs, and, with the pulmonary veins, constitutes the pulmonic, or the lesser circulation: the aorta conducts the red or pure blood, impelled into it from the left ventricle, through all parts of the body, and, together with the corresponding or returning veins, constitutes the great systemic or corporeal circulation. These two systems are perfectly distinct and separate in the adult, but during the fœtal life, they communicate through the foraman ovale in the auricular septum, and through the ductus arteriosus, which opens from the pulmonic trunk into the aorta. The pulmonary artery has been already described in the anatomy of the heart, page 110. The aorta and its ramifications shall now be considered: these may be compared to a tree. the aorta itself being the trunk, extending from its root in the heart, along the spinal column, to the pelvis, while the branches are the numerous divisions and sub-divisions ramifying throughout the body, and more or less pervading every texture, except the epidermis, nails, and hair: as the combined areæ of all these branches must greatly exceed the diameter of the parent tube, the entire tree resembles a cone, whose apex is in the aorta, and whose base is expanded throughout the entire system. The several arterial divisions are named partly from their regional situation, as subclavian axillary, brachial, femoral, &c.; partly from their relative position, as superficial or deep, anterior, or posterior, &c.; and partly from their destination, as cerebral, ophthalmic, renal, spermatic, &c. The names "artery" and "aorta" have their origin in the absurd notion of the ancients, who, ignorant of the true course of the circulation of the blood, supposed that these tubes were filled with vital air or spirit; long and continued usage, however, has established these erroneous titles. The origin of the aorta from, and its connection to the heart, have been already considered (page 112). The branches arise from this trunk, according to different plans in different situations; in some, a large vessel bifurcates into its terminal branches; this dichotomous division, which takes place at an acute angle, with an internal projecting crest, favors

the current into the branches; thus the common carotids divide into internal and external, the brachial into radial and ulnar, the aorta into right and left iliac, the popliteal into anterior and posterior tibial, &c. In other places the branches arise at a right, or even an obtuse angle, as the lumbars and intercostals, &c; this would appear unfavorable to a rapid passage, and may even be designed to retard the flow of blood, or lessen the impetus of the heart's action. Some arteries continue a long course without giving off any branches, or but a few small ones, and others terminate abruptly in a number of branches diverging in a radiated manner, as the cæliac and the thyroid axis. Arteries vary much as to their course, being straight, curved, retrograde, serpentine, tortuous, coiled, &c. Arteries terminate in anastomoses, and in the minute network of vessels termed the *capillary system;* this again communicates with the veins. The capillaries can seldom be filled by injection, or exposed by dissection without the aid of the microscope, except in some situations; they can be best observed and admired in the transparent textures of some animals during life, as in the web of the frog; the capillaries pervade almost all parts of the body, but vary greatly as to number and development in different tissues; they are the seat of nutrition and secretion, the ultimate objects of the circulation of the blood.

The anastomoses of arteries are numerous and on varied plans; the most common is that by inosculation, that is, when two vessels running in opposite directions meet and form one loop, as in the arteries of the mesocolon and mesentery; this plan is almost universal in the smaller arteries and in the capillaries; by it collateral circulation is maintained, a free supply of blood is secured, and protection afforded against any impediment or interruption in the course of this fluid; it is on these inosculations, and their remarkable capability of becoming so enlarged as to establish a free collateral circulation when any main artery is obstructed, that the practice of applying a ligature on even a large vessel is founded, without any apprehension as to an insufficient supply of blood to the parts beyond it. Anastomosis also occurs by two large arteries converging into one, as the two vertebrals into the basilar; or sometimes two vessels are connected by a transverse branch, as in the case of the anterior arteries of the brain.

The arterial tubes are of a dense structure, and preserve their form when empty, when divided also after death they remain open and do not collapse; they are composed of three principal coats or tissues; the *first* or *external* is cellular or fibro-cellular, strong and resisting, connects the vessels to the surrounding parts, and contains its nutrient nerves and vessels; it is composed of a close, filamentous, areolar tissue, which never contains any adeps, and presents some glistening fibres, partly circular, partly longitudinal; it most probably possesses some organic contractility.

The *second* or *middle*, or *proper coat*, is the thickest; it consists of yellowish and rather dry fibres, elastic, but brittle; they are chiefly circular, but do not form complete rings; they are easily separated longitudinally, and, together with the inner coat, are cleanly cut through by a circular ligature; this coat is eminently elastic, particularly in the large arteries. Minute anatomists, with the aid of the microscope, divide this coat into three laminæ, an external, thin, yellow, elastic one, most distinct in the larger tubes; a middle, composed of circular fibres, similar to those of unstriped involuntary muscle; and an internal, of similar fibres but in the longitudinal direction. The *internal coat* of an artery, smooth and polished, resembles serous membrane, and is often thrown into longitudinal plicæ; it has been subdivided into two laminæ: the internal composed of tesselated epithelium; this rests on a basement membrane, the fibres of which are chiefly longitudinal and interlaced, leaving numerous openings between them: the internal and middle tunics are connected by fine cellular tissue, in which those calcareous patches, so com-

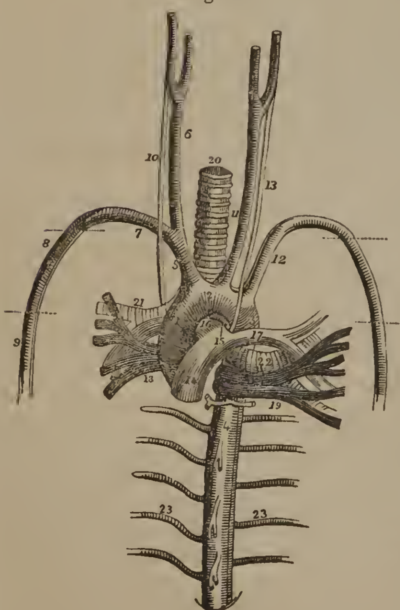
mon in the arterial system are first deposited. The arterial tunics, therefore, may be enumerated as seven in number, viz: the external, or fibro-cellular; the three laminæ of the middle or fibrous; the intervening cellular tissue between the internal and middle coats; and lastly the epithelium and its basement layer. The arteries are supplied with nutrient vessels and nerves from the adjacent parts; the aorta and the abdominal arteries exhibit these most perfectly. Although the arterial system is devoid of exact symmetry, yet, with a few exceptions, one description will apply to either side; the principal arteries are surrounded by a cellular and fibrous tissue named their sheath, and which also usually contains the accompanying veins and nerves.

The principal bloodvessels have been already noticed in the anatomy of the different regions. In the present section the arteries shall be considered in a systematic manner, commencing with the aorta, and tracing its branches through all parts of the body.

Aorta arises from the upper part of the left ventricle, opposite the fourth or fifth dorsal vertebra (*see* pages 109 and 112), ascends obliquely forwards and to the right side, behind the second bone of the sternum, to a level with the second sterno-costal articulation; it then bends backwards and to the left side, and, corresponding to the second dorsal vertebra, makes a second turn in a direction downwards, and thus forms the *arch*, which is said to terminate at the left side of the body of the third or fourth dorsal vertebra: the continued trunk receives the name of descending aorta, and is subdivided into the thoracic and abdominal.

The *arch* of the *aorta*, though not very accurately defined, may be considered as extending from the left ventricle to the fourth dorsal vertebra, and may be divided into three portions, the anterior or ascending, the middle or transverse, and the posterior or descending.

Fig. 66.*



The *first*, or the *ascending*, is inclosed in the pericardium, and covered at first by the infundibulum and root of the pulmonary artery; as it ascends, this latter vessel lies to its left side, and the vena cava to its right; behind it are the right pulmonary artery and veins; the serous membrane attaches and incloses it and the pulmonary artery in one common sheath, and of course leaves uncovered only so much of each vessel as is in immediate contact.

The *second* or *transverse*, or *horizontal* portion, is external to the pericardium; the left vena innominata and the remains of the thymus gland are anterior to it; behind it, and rather to its right side, are the

* A view of the great vessels which are connected to the base of the heart. 1. The ascending portion of the arch of the aorta. 2. Its transverse portion. 3. Its descending portion. 4. The thoracic aorta. 5. The arteria innominata. 6. The common carotid artery of right side. 7. The right subclavian artery. 8. The axillary artery. 9. The brachial artery. 10. The right pneumogastric nerve. 11. The left common carotid artery. 12. The left subclavian. 13. The left pneumogastric nerve. 14. The trunk of the pul-

trachea, œsophagus, thoracic duct, and left recurrent nerve: the left pleura and left lung are anterior to its left side.

The *third* or *descending*, or *posterior* portion, is the shortest, is directly behind the bifurcation of the pulmonary artery, and united to it by the ligamentous remains of the ductus arteriosus; the left pneumogastric nerve and left bronchial tube are in front of it; its right side corresponds to the œsophagus, thoracic duct, and left side of the third dorsal vertebra; its left side and a portion of its circumference are enveloped by the left pleura.

The convexity of the arch is directed upwards, forwards, and to the right; the concavity is directed downwards towards the root of the left lung, and is embraced in a sort of loop by the left recurrent nerve; a number of lymphatic glands, together with the parts already mentioned, occupy this concavity. The aorta is by no means so uniformly cylindrical as other arteries; close to its origin it presents three small swellings corresponding to the semilunar valves; these are named the "lesser aortic sinuses," and exist at all periods of life; and again, at the upper and anterior part of the arch, it is usually in old persons very much dilated on its convex aspect; this is named the "great sinus," and may be considered abnormal. From the arch of the aorta five arteries arise, the right and left coronary, the innominata, the left carotid, and left subclavian. Exceptions to this arrangement not unfrequently occur; thus, independent of the coronaries, sometimes but two arteries arise from the arch, sometimes six, and there may be any number between these extremes; when only two, these are usually a right and left innominata, which subdivide each into the carotid and subclavian; when there are four or more, the additional branches may be the right carotid, the right and left vertebral. Many of these apparent anomalies are analogous to the regular order in some other class of animals, and others can be referred to the principle of an early or late origin of primary branches. The right subclavian very frequently arises from the left extremity of the transverse portion of the arch, and then it passes upwards and to the right side, crossing the spine behind the œsophagus, and rarely between it and the trachea; in such cases there is no innominata, and the right carotid arises from the arch in its place.

The *right and left coronary arteries* are the nutrient vessels of the heart; they rise above two of the sigmoid valves; the *right* proceeds along the base towards the right side of the heart, divides into several long branches, which supply the parietes of the right auricle and ventricle, and communicate with the left coronary: the *left* descends obliquely along the left side of the heart, supplying the parietes of the left auricle and ventricle, and communicating with the former around the base and apex of the heart. These arteries have been minutely described in the Anatomy of the Heart, (see page 115:) their number is not uniform; sometimes there is but one common trunk, sometimes there are three, and even four, but such varieties do not affect their general distribution, and may be regarded as branches which arise from the aorta, instead of from the coronary arteries themselves.

The *arteria innominata* arises from the upper part of the arch, at the angle or junction between the ascending and horizontal portion; it is from an inch to an inch and a half in length, ascends obliquely to the right side, in front of the trachea and of the right pleura, and behind the sterno-hyoid and thyoid muscles and the left vena innominata; opposite the sternal end of the clavicle it divides into the right subclavian and right carotid arteries.

The *right and left carotid arteries*. The *right* arises from the innominata,

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monary artery. 15. The obliterated artery. 16. The right pulmonary artery. 17. The left pulmonary artery. 18. The right pulmonary veins. 19. The left pulmonary veins. 20. The trachea. 21. The right bronchus. 22. The left bronchus. 23. 23. The intercostal arteries. The small branches, arising from the forepart of the aorta, are distributed to the pericardium and œsophagus.

the *left* from the arch of the aorta: these vessels ascend obliquely outwards as high as the os hyoides, opposite which each divides into the internal and external; in this course they are covered inferiorly by the sterno-mastoid, hyoid, thyroid, and omo-hyoid muscles, and superiorly only by the skin, platysma, and fascia; the left, in consequence of the obliquity of the arch of the aorta, lies much deeper at its origin than the right, and is in addition covered inferiorly by the sternum and the vena innominata, and lies on the treachea, thoracic duct, œsophagus, and left subclavian: in this lower or thoracic portion, which is nearly an inch long, it is related externally to the left pleura and phrenic nerve, and internally to the arteria innominata, from which it separates by a triangular interval, in which the trachea appears; but after this both ascend in front of the longus colli and rectus capitis muscles, the inferior thyroid artery, and the recurrent and sympathetic nerves, and are inclosed in a sheath of cellular membrane, along with and to the tracheal side of the vagus nerve and the internal jugular vein; the descendens noni nerve lies superficial to this sheath. The right carotid is sometimes larger than the left; it is also on a plane anterior to it, at least in the lower part of the neck, and is less closely connected to its accompanying vein.

The *external carotid artery* ascends obliquely backwards to the forepart of the meatus auditorius, covered by the skin, platysma, and fascia, also by the lingual nerve, digastric and stylo-hyoid muscles, the parotid gland, and portio dura nerve; it lies superficial to the internal, carotid, stylo-pharyngeus, and stylo-glossus muscles, the glosso-pharyngeal nerve, and part of the parotid gland; it gives off the ten following arteries: anteriorly, the superior thyroid, lingual, and labial; posteriorly, the muscular, auricular, and occipital; superiorly, the pharyngeal, transverse facial, temporal, and internal maxillary.

The *superior thyroid artery* arises opposite the cornu of the thyroid cartilage, descends obliquely forwards and inwards beneath the sterno-thyroid and omo-hyoid muscles, and sends off the following branches: first, the *superficial*, distributed to the teguments and superficial muscles; second, the *laryngeal*, accompanying the superior laryngeal nerve, between the os hyoides and thyroid cartilage, and distributed to the muscles and mucous membrane of the larynx; third, *hyoidean*, small and irregular, to the lower border of the os hyoides and adjacent muscles; and, fourth, *superior thyroid*, is distributed to the thyroid gland.

The *lingual artery* arises immediately above the preceding; it ascends tortuously and obliquely forwards and inwards, above the os hyoides, to the base of the tongue, between the hyo and the genio-hyoglossi muscles, and then runs horizontally forwards towards the tip of the tongue; it gives off the following branches: first, *hyoidean*, small and irregular; second, *dorsalis linguæ*, which ascends to the dorsum of the tongue, and is lost on the mucous membrane near its base, also on the velum and fauces; third, *sublingual*, passes forwards and outwards to the sublingual gland, mylo-hyoid muscle, and mu cous membrane of the mouth; and, fourth, the continued trunk named *ranine*, which continues along the lingualis muscle to the tip of the tongue.

The *labial* or *external maxillary artery* arises opposite the os hyoides, ascends obliquely forwards behind the digastric and between the submaxillary gland and the base of the jaw, turns round the latter anterior to the masseter muscle, and then ascends obliquely forwards and inwards towards the side of the nose; in the neck it gives off, first, *inferior palatine*, which ascends along the side of the pharynx, and supplies the velum and the amygdala; the branch to the latter often arises distinctly; second, *glandular*, to the submaxillary and adjoining lymphatic glands; third, *submental* runs along the mylo-hyoid muscle to the chin, and supplies the surrounding muscles. On the face it gives off, fourth, *inferior labial* to the muscles and integuments between the lip and chin; fifth, the *inferior* and *superior coronary;* these

run along the border of the lips, close to the mucous membrane, and directly join those from the opposite side; sixth, *lateralis nasi*, to the muscles and skin on the side and dorsum of the nose; and, seventh, *angularis*, which communicates with the ophthalmic.

The *muscular artery* descends obliquely backwards, divides into several branches, which are principally distributed to the sterno mastoid, and to the surrounding cellular tissue and glands.

The *occipital artery* arises opposite the labial, ascends obliquely backwards behind the digastric, then curves horizontally backwards between the mastoid process and the atlas, and near the mesial line it ascends on the occiput; it gives off several muscular branches, some to the mastoid and trapezius muscles, several to the deep muscles on the side and back of the neck, and on the occiput it divides into tortuous branches, which ascend in different directions in the scalp, and inosculate with the different arteries in that region.

The *posterior auricular artery* arises above, often in common with the occipital; it ascends behind the parotid and between the meatus auditorius and the mastoid processes; it divides into several branches, which are lost in the integuments of the ear and in the scalp; it gives off one branch which requires special notice, the *stylo-mastoid;* it enters by the foramen of that name into the aqueduct of Fallopius, and its terminal branches are distributed to the tympanum.

The *inferior* or *ascending pharyngeal artery* arises near the division of the common carotid, ascends vertically to the base of the skull, and sends off several pharyngeal and palatine branches, and ends in a small branch that passes through the foramen lacerum posterius, and supplies the dura mater at the base of the cranium.

The *transverse artery of the face* arises from the carotid in the parotid gland, accompanies the duct of Steno, and is distributed to the muscles and integuments of the face, and joins the branches of the facial artery.

The *temporal artery* ascends through the parotid gland between the meatus auditorius and the articulation of the maxilla, behind the zygoma, and divides on the temporal fascia into an anterior and posterior branch; it gives off, first, *branches to the gland;* second, *anterior auricular;* third, the *middle temporal;* this pierces the fascia, and is distributed to the temporal muscle; fourth, the *anterior* or *frontal* supplies the skin and muscles of the forehead, and joins the ascending branches of the ophthalmic artery; fifth, *posterior temporal* bends backwards and upwards to the scalp, and inosculates with the occipital and auricular arteries.

The *internal maxillary artery* ascends obliquely forwards behind the neck of the maxilla, between the pterygoid muscles; and, lastly, between the external pterygoid and the temporal muscle into the pterygo-maxillary fossa; to expose it, the zygomatic arch must be sawn through at each end, and depressed together with the masseter muscle; the temporal muscle raised from the coronoid process, the ramus of the jaw divided near its centre, and its articulation dislocated; a little dissection will then expose this vessel, along with the deep branches of the inferior maxillary nerve, between the pterygoid muscles. It first passes horizontally forwards, between the neck of the jaw and its internal lateral ligament, and is related to the dental and gustatory nerves; it then enters a space inclosed between the temporal, pterygoid, and buccinator muscles, winds over the external pterygoid, and then bends tortuously downwards into the pterygo-maxillary fossa. It gives off the following branches: first, while internal to the neck of the maxilla, the *middle artery of the dura mater;* this ascends to the base of the cranium, passes through the spinous hole of the sphenoid bone, and divides into an anterior and posterior branch; the former is the larger, crosses the great wing of the sphenoid bone, enters the groove or canal in the anterior inferior angle of the parietal

bone, and soon divides into numerous branches, of which one rather large ascends towards the vertex, parallel but posterior to the coronal suture. The posterior branch crosses the squamous portion of the temporal bone, and ramifies on the parietal. These vessels supply the bones of the cranium and the dura mater; small branches also pass into the internal ear through the hiatus Fallopii. Second, the *inferior dental* arises opposite the last, descends obliquely forwards between the bone and the internal lateral ligament, enters the dental foramen, and proceeds beneath the teeth, to the roots of which it sends very small arteries, and through the mental hole it sends a small branch to the muscles and mucous membrane, and to inosculate with branches of the labial artery; between the pterygoid muscles it sends off, third, the *deep temporal* branches, one posterior, the other anterior; these supply the muscle, and ascend close to the bone; fourth, *masseteric;* fifth, *pterygoid;* sixth, *buccal*, to the buccinator muscle, the fat and integuments of the cheek; seventh, *superior dental*, which winds round the maxillary tuberosity, and sends branches into the alveoli and to the gums; in the spheno-maxillary fossa it gives off, eighth, *infra-orbital*, which, from its size, would appear to be the continued trunk; it passes along the canal of that name, sends branches downwards to the antrum, and to the incisor and canine teeth, is finally distributed to the muscles of the face, and communicates with the arteries of that region; ninth, *nasal*, passes inwards through the spheno-palatine hole, and is distributed to the mucous membrane on the spongy bones and on the septum; tenth, the *superior palatine*, descends along the posterior palatine canal, and is distributed partly to the muscles and to the mucous membrane of the velum, but principally to the hard palate, on which one branch curves forwards in a bony groove internal to the alveoli, and inosculates in the anterior palatine canal with the spheno-palatine artery; eleventh, the *vidian;* this is a small branch which passes backwards, and takes the course of the first part of the vidian nerve; these terminating branches of the internal maxillary artery are entangled with the divisions of the superior maxillary nerve.

The *internal carotid artery* ascends along the vertebral column and the side of the pharynx from the common carotid, posterior and external to the external carotid, behind the digastric and styloid muscles, internal to the jugular vein and anterior to the vagus and sympathetic nerves, to the foramen caroticum in the petrous bone; it then bends tortuously forwards, upwards, and inwards, through the carotid canal, accompanied by the superior branches of the sympathetic, enters the cavernous sinus, through which it makes two remarkable turns internal to the sixth pair of nerves, and, arriving at the anterior clinoid process, it bends upwards and backwards, and a little outwards, and opposite the internal extremity of the fissure of Sylvius divides into its three terminating branches, viz., posterior communicans, anterior cerebri, and media cerebri. This vessel, through its entire course, is remarkable for its tortuosity; in the neck it is very variable in this respect, but is generally bent into several curves, and often dilated irregularly, and of a larger calibre than when it has entered the cranium; in the carotid canal and cavernous sinus it is always curved in the form of the italic *S*, placed horizontally. In the neck and in the carotid canal it sends small and unimportant branches to the surrounding parts; one, named tympanic, enters a small hole in the carotid canal, and is distributed to the tympanum; one or two meningeal branches to the dura mater and adjacent bones; the first branch of any importance is the following:

The *ophthalmic artery* arises close to the anterior clinoid process, passes forwards through the optic foramen, below the optic nerve and external to it; in the orbit it arises above this nerve, and twines round it to the inner side of this cavity, along which it passes to the inner canthus, where it terminates. While on the outer side of the optic nerve it sends off, first, *centralis retinæ*,

very small, pierces the sheath of the optic nerve, passes along the centre of the latter into the eye, where it divides into delicate ramifications; these spread along the internal layer of the retina, and one or two pierce the vitreous humor, and extend to the capsule of the lens; second, the *lachrymal* passes along the external rectus muscle, and supplies the lachrymal gland, and the external part of the palpebræ; while above the optic nerve it gives off, third, the *supra-orbital*, which passes forwards along the levator palpebræ, and through the superciliary notch, supplies the muscles and integuments of the eyebrow, and, ascending on the forehead, divides into several branches, which are distributed to the scalp, and communicate with the temporal and occipital arteries; fourth, the *posterior ciliary*, ten or twelve in number, very small, surround the optic nerve, and pierce the back part of the sclerotic, pass between it and the choroid, and are distributed to the latter; some of their branches continue as far as the ciliary processes and the iris; fifth, *long ciliary*, one on each side; they pass horizontally forwards, between the sclerotic and choroid membranes, as far as the ciliary circle; here they divide, and form a circular inosculation round the circumference of the iris; from this several branches radiate inwards, and again unite in a circle near the pupil; sixth, *muscular arteries*, to the different muscles in the orbit; seventh, *ethmoidal*, passes through the posterior orbital foramen to the mucous membrane in the ethmoid cells; eighth, *superior and inferior palpebral*, to the palpebræ, caruncula, conjunctiva, and lachrymal sac; ninth, *nasal*, passes beneath the trochea, along the side of the nose, and inosculates with the labial artery; tenth, *frontal*, ascends to the eyebrow and forehead.

The *posterior communicating artery* arises from the carotid, opposite the ophthalmic; passes backwards and inwards, external to the corpora mamillaria, and joins the posterior cerebral artery; this artery forms the lateral part of the circle of Willis: it sends several branches to the surrounding pia mater.

The *anterior cerebral artery*, or *arteria callosa*, passes forwards and inwards above the optic nerve; anastomoses with the opposite, by a short transverse branch (the anterior communicating artery); it then bends upwards and backwards round the corpus callosum, on which it terminates by dividing into branches for the corresponding hemisphere of the cerebrum.

The *middle cerebral artery*, very large, passes outwards in the fissure of Sylvius, and divides into two tortuous branches, which supply the anterior and middle lobes of the cerebrum; these branches are remarkably tortuous, and sink deep into the sulci between the convolutions in the island of Reil; these coils can be drawn out from the depressions, and they can be traced along the side of each hemisphere, even to the vertex; at the inner extremity of the Sylvian fissure a number of small branches arise from this vessel, and pass through the external perforated substance to supply the corpus striatum.

The *subclavian arteries*. The right and left subclavian arteries differ in diameter, length, situation, and relations. The right arises from the innominata, and is consequently shorter than the left, which springs from the back part of the middle portion of the arch of the aorta; the right is also larger and situated more anteriorly in the neck. The course of each may be divided into *three stages*, the *first* extends from the origin to the tracheal edge of the anterior scalenus muscle; this stage is much longer on the left than upon the right side; the *middle stage* is the transit of the artery between the scaleni muscles; the *third stage* extends from these muscles beneath the clavicle to the lower border of the first rib, below which the continued trunk receives the name of axillary artery; in the middle and last stages, the right and left arteries are similarly circumstanced in all respects.

The *right subclavian* in its first stage passes outwards, and a little upwards,

having anterior to it, the internal jugular and subclavian veins, the pneumogastric, cardiac, and phrenic nerves; the first of these crosses it at right angles, and sends its recurrent beneath and behind it; the sterno-mastoid, hyoid, and thyroid muscles, with more or less of cellular tissue, are also anterior to it; behind it are the recurrent and sympathetic nerves, the vertebral vein, cellular tissue and lymphatic glands, which separate it from the vertebræ and correspond to a depression between the longus colli and scalenus muscle. The *left subclavian* from its origin to the scalenus is nearly vertical, and has anterior to it, the sterno-mastoid, hyoid, and thyroid muscles, the clavicle and first rib, the left vena innominata, left carotid artery, the pneumogastric, phrenic, and cardiac nerves, and also branches of the sympathetic, together with the left lung and pleura; the pneumogastric nerve does not cross it at right angles as upon the right side, but descends parallel to it, and its recurrent winds around the arch of the aorta, and then ascends behind the left subclavian. This vessel is separated from the vertebræ by the longus colli muscle and sympathetic nerve: at first it is in front of the thoracic duct, but as it ascends it lies to the left side of it and of the œsophagus. The subclavian artery in the *middle stage* of its course, on each side of the neck, is covered by the sterno-mastoid and anterior scalenus muscle, and phrenic nerve, and lies upon the pleura and middle scalenus, accompanied by the brachial plexus of nerves which is superior and external to it; the subclavian vein is inferior and anterior, the anterior scalenus being interposed.

In its *third stage* it inclines downwards and outwards, and is covered only by the skin, platisma, fascia, and cellular tissue, it rests upon the middle scalenus and the first rib; the plexus of nerves and the omo-hyoid muscle are superior and external to it; the vein is anterior and inferior, concealed by the clavicle. The subclavian arteries send off the following branches, vertebral, thyroid axis, internal mammary, superior intercostal, and deep cervical.

The *vertebral artery* arises from the upper and back part of the subclavian; ascends behind the inferior thyroid artery, enters the foramen in the transverse process of the fifth or sixth cervical vertebra, and ascends through the several foramina in the superior vertebræ as high as the second; it then bends backwards and outwards in an exceedingly tortuous manner, passes through the foramen in the transverse process of the atlas, and curving backwards and inwards round the articulation of this vertebra with the condyle pierces the dura mater; it then ascends obliquely inwards and forwards between the olivary and pyramidal bodies, and at the lower edge of the pons it unites with the opposite, to form the basilar artery; in this course it gives small branches to the spinal nerves, and to the inter-vertebral muscles; at the foramen magnum it gives off, first and second, the *posterior and anterior spinal arteries*, which descend all along the spinal cord; third, the *inferior cerebral artery* (this often arises from the basilar), it runs tortuously around the medulla oblongata, below the vagus, and sends its numerous branches to the inferior surface of the cerebellum.

The *basilar artery* is formed by the confluence of the two vertebral; it ascends in the median groove on the pons varolii, sends small branches to the surrounding membrane, and at the upper edge of that body it divides into four branches, two for each side; first, the *superior cerebellar artery*, passes outwards and backwards, to the upper surface of each hemisphere of the cerebellum, on which it spreads its branches; second, the *posterior cerebral artery*, this receives the posterior branch of the internal carotid, bends backwards and outwards, and spreads its ramifications on the posterior lobe of the cerebral hemisphere. The communication between these posterior cerebral arteries and the posterior branches of the internal carotids, completes that remarkable inosculation named the "circle of Willis:" this is formed anteriorly, by the two anterior cerebral arteries with their cross uniting branch, laterally

each internal carotid and its posterior communicating branch, and posteriorly by the trunk of the basilar and the roots of the posterior cerebral arteries.

The *thyroid axis* arises from the upper part of the subclavian, close to the scalenus and phrenic nerve; it immediately divides into the four following branches:—First, the *inferior thyroid*, ascends tortuously behind the common carotid, then bends downwards and inwards, sends branches to the trachea, œsophagus, &c., and is distributed to the thyroid gland, in which it inosculates with the superior thyroid, and with the arteries of the opposite side; second, the *ascending cervical* ascends along and is distributed to the anterior scalenus, longus colli, and rectus capitis anticus major muscles; third *supra-scapular* runs obliquely outwards and downwards beneath the clavicle, passes above the notch in the superior costa of the scapula, supplies the supra-spinatus muscle, and descends beneath the acromion process to the infra-spinatus and teres minor muscles; fourth *transversalis colli* ascends obliquely outwards round the scaleni muscles, and beneath the trapezius; it divides into two branches, one, the *cervicalis superficialis*, supplies the superficial muscles on the side and back part of the neck; the other, the *posterior scapular artery*, descends beneath the levator anguli scapulæ, and the rhomboid muscles, along the base of the scapula as far as the inferior angle, where it inosculates with the subscapular artery; the posterior artery of the scapula, as also the supra-scapular, in many subjects, arise distinctly from the subclavian artery.

The *internal mammary artery* arises opposite the thyroid axis, it descends obliquely forwards and inwards, between the cartilages of the ribs and the pleura, as far as the ensiform cartilage; it gives branches to the pleura, pericardium, and mediastinum, a long branch to the diaphragm, which accompanies the phrenic nerve, also intercostal branches, which inosculate with the aortic intercostals; it terminates by sending branches to the diaphragm, and to the abdominal muscles: the latter inosculate with the epigastric artery.

The *superior intercostal artery* arises between the scaleni, descends behind the pleura, in front of the neck of the first and second ribs, and supplies the two first pair of intercostal muscles.

The *cervicalis profunda* arises opposite the last, ascends obliquely backwards and outwards, between the transverse processes of the sixth and seventh cervical vertebræ, and ascending on the back of the neck, supplies the complexus and the other deep muscles in that region, and inosculates with the descending branches of the occipital artery.

The *axillary artery* descends from the lower edge of the first rib, obliquely outwards, to the tendon of the latissimus dorsi muscle, is covered by the integuments, and at first by the external border of the great pectoral muscle, and still lower down by the tendon of the great pectoral only; it passes over the first intercostal, and serratus magnus muscles, the brachial plexus, the subscapular, and the tendons of the latissimus dorsi and teres major muscles; the axillary vein descends along its inner and anterior part, and the brachial plexus lies posterior and external to it; it sends off the following arteries: the thoracica acromialis, the superior and long thoracic, the subscapular, the posterior and interior circumflex.

The *acromial thoracic artery* arises from the front of the axillary below the subclavian muscle, above the lesser pectoral, and opposite the fissure between the great pectoral and deltoid muscles; it divides into several branches, which pass, some to the pectoral muscles, others to the acromion process, deltoid muscle, and integuments of the shoulder and arm; one long branch accompanies the cephalic vein.

The *superior thoracic artery* arises a little below the preceding, sometimes in common with it; it passes forwards and inwards, and divides into branches which supply the cellular membrane and glands in the axilla, the pectoral muscles, the breast, and the integuments.

The *long thoracic artery* arises below the lesser pectoral, descends obliquely forwards, along the side of the chest, parallel to the lower edge of the great pectoral, to which it sends some branches; it terminates in the intercostal muscles and integuments, and inosculates with the internal mammary and the intercostal arteries.

The *subscapular artery* arises opposite to and descends along the lower edge of the subscapular muscle, and soon divides into an anterior and posterior branch; the former continues to descend along the back part of the axilla, and supplies the subscapular, serratus magnus, and latissimus dorsi muscles; the latter passes backwards round the inferior costa of the scapula, behind the long tendon of the triceps, and above the latissimus and teres major muscles; it is distributed on the dorsum of the scapula to the infra-spinatus and teres minor muscles, and inosculates with the supra-scapular artery.

The *posterior circumflex artery* arises below the last, sometimes in common with it; it passes out of the axilla between the long tendon of the triceps and the humerus, turns round this bone between it and the deltoid muscle, to which last it sends numerous branches.

The *anterior circumflex artery* is smaller than the preceding, and arises either from it or from the axillary; it passes outwards round the anterior part of the humerus, beneath the deltoid, coraco-brachialis, and biceps; to these muscles it sends its branches; it also sends one long branch along the bicipital groove to the synovial membrane of the shoulder joint.

The *brachial artery* descends obliquely outwards to the bend of the elbow, where it divides into the radial and ulnar arteries; it is covered by the skin and brachial aponeurosis, and inferiorly by the fascia of the biceps, and the median basilic vein; it lies on the inner side of the coraco-brachialis and biceps, and passes over the upper part of the triceps, the coraco-brachialis, and the brachiæus anticus; it is accompanied by a vein on either side, also by the median nerve, which above lies to its outer, and below to its inner side; it passes superficial to the artery about the middle of the arm: in addition to several muscular branches it sends off the superior and inferior profunda, and the anastomotica.

The *superior profunda* arises below the teres major, accompanies the musculo-spiral nerve obliquely downwards and outwards, between the three heads of the triceps, and in the musculo-spiral groove of the humerus; it divides into two large branches, one descends in the triceps to the olecranon, the other accompanies the radial nerve to the outer condyle, and communicates with the radial recurrent artery.

The *inferior profunda* arises opposite the tendon of the coraco-brachialis, descends on the surface of the triceps, along with the ulnar nerve, to the inner condyle, and communicates with the ulnar recurrent.

The *anastomotica* arises about two inches above the joint, passes inwards, supplying the adjacent muscles, and inosculating with the preceding and with the ulnar recurrent arteries.

In the triangular hollow at the bend of the elbow, the brachial artery divides into the radial and ulnar.

The *ulnar artery* is the larger of the two, it descends along the ulnar side of the forearm to the palm of the hand, covered superiorly by the superficial flexors and pronators, and by the median nerve; inferiorly by the skin and fascia, overlapped, however, by the tendons of the flexor digitorum sublimis and flexor carpi ulnaris, between which it descends to the wrist; it passes over the brachiæus anticus, flexor profundus, pronator quadratus, the annular ligament of the carpus, and the flexor tendons in the palm of the hand; it is accompanied by two veins, and by the ulnar nerve, the latter descends along its ulnar side; it gives off, first, the *anterior ulnar recurrent*, which ascends in front of the inner condyle, on the brachiæus anticus, and inosculates with

the anastomotica; second, the *posterior ulnar recurrent*, large and tortuous, ascends behind the inner condyle, along with the ulnar nerve, and anastomoses with the anastomotica and inferior profunda arteries; third, *interosseal artery*, passes backwards and divides into an anterior and posterior branch; the *anterior interosseal artery* descends along the forepart of the interosseal membrane, beneath the deep flexors, pierces that membrane near the pronator quadratus, and descends on the back part of the carpus, and is distributed to the carpal bones, and to the sheaths of the extensor tendons; the *posterior interosseal artery* passes backwards beneath the anconæus, and descends along the back of the forearm, sending its branches to the extensor muscles; this artery superiorly sends a very large recurrent branch in the anconæus muscle to the olecranon, to communicate with the superior profunda; fourth, *muscular branches* to the two layers of flexor muscles, and to the skin; fifth, *dorsalis carpi ulnaris* turns round the lower end of the ulna, and spreads its branches on the back part of the wrist and hand; sixth, *superficial palmar*, forms the palmar arch, bends obliquely across the palm of the hand towards the thumb, and inosculates with branches of the radial artery; seventh, *ramus profundus*, passes beneath the flexor tendons, crosses the fifth and fourth metacarpal bones, joins the deep palmar branch of the radial artery, and thus completes the deep palmar arch; from the superficial arch long digital branches pass, these divide and supply the opposite sides of all the fingers, except the radial side of the index finger and the thumb.

The *radial artery* continues in the direction of the brachial artery; it passes along the radial side of the forearm to the wrist, turns round the external lateral ligament of this joint, then passes forwards between the heads of the two first metacarpal bones into the palm of the hand, and terminates in three branches; in the forearm it is covered by the skin and fascia only, lies between the supinator longus externally, and the pronator teres and flexor carpi radialis internally; it passes over the biceps, supinator brevis, pronator teres, flexor digitorum sublimis, flexor pollicis, and pronator quadratus; it is accompanied by two veins, and the radial nerve is to its external side in the middle of the forearm; on the outer side of the wrist it is covered by the extensor tendons of the thumb, and on the back of the hand by the skin and fascia; it gives off, first, *radial recurrent*, large and tortuous, bends outwards and upwards along the supinators and extensors, to which it sends several branches, and inosculates with the superior profunda; second, *muscular branches* to the flexors and supinators; third, *superficialis volæ* passes over the annular ligament of the carpus, supplies the small muscles of the thumb and inosculates with the ulnar artery; fourth, *dorsalis carpi radialis;* fifth *dorsalis pollicis;* these branches are distributed as their names imply; sixth, *radialis indicis* runs along the radial side of the forefinger; seventh, *magna pollicis* runs along the first metacarpal bone, and divides into two branches, which pass along the opposite sides of the thumb to its last phalanx; eighth, *palmaris profunda* passes across the metacarpal bones, joins the deep branch of the ulnar, and thus forms the deep palmar arch, from which several branches proceed to the interosseal muscles, and to the bones and ligaments of the metacarpus.

The Thoracic Aorta descends obliquely forwards, from the termination of the arch to the diaphragm; above it is to the left side of the spine, but below it nearly corresponds to the median line; it is inclosed in the posterior mediastinum; the root of the left lung above, the heart and pericardium in the middle, and the œsophagus with the vagi nerves below, are anterior to it; the vertebral column is behind, the left intercostal veins alone intervening, and the left vena azygos when present. On the left side it is closely related to the left lung and pleura, and inferiorly, to the left splanchnic nerve; on the right to the thoracic duct and vena ozygos, and, superiorly, to the œsopha-

gus: several lymphatic glands are attached to it, and much cellular tissue containing numerous small vessels and nerves, surrounds it; it gives off the bronchial, œsophageal, and intercostal arteries.

The *bronchial arteries* are two or three in number; they arise from the forepart of the aorta, below the arch; they pass to either side, enter the back part of the root of each lung, and are lost in the cellular tissue of these organs; these arteries sometimes arise from the intercostal; they are very irregular in number and size.

The *œsophageal arteries* are also irregular, generally three or four in number; they arise from different parts of the aorta, send branches to the mediastinum and œsophagus; on the latter some ascend, others descend; the former inosculate with the cervical arteries, the latter with the abdominal.

The *intercostal arteries,* in general ten on the left, nine on the right side, the superior intercostal on the right side being larger than that on the left; they arise from the back part of the aorta, pass obliquely outwards behind the pleura, and enter the intercostal spaces, run along the lower edge of each rib between the layers of muscles, and about the middle of the chest divide into an inferior and superior branch; the former, smaller, runs along the superior border of the lower rib; the latter continues in the groove in the upper; they both supply the intercostal muscles, and send branches through these to the pleura and to the superficial muscles of the chest: they inosculate with the internal mammary and with the thoracic arteries. Each intercostal artery, before it enters the intercostal space, sends a large branch backwards, between the transverse processes of the vertebræ, to the muscles on the posterior part of the trunk; these *dorsal branches* of the intercostal arteries also send small branches through the intervertebral holes, along the spinal nerves, to the medulla spinalis.

The Abdominal Aorta commences below the tendinous arch, between the crura of the diaphragm in the median line, descends with a slight obliquity to the left, and divides at the lower margin of the fourth lumbar vertebra into the two iliac arteries; the middle sacral may also be considered as one of its terminal branches. The following are its principal relations: anteriorly, the solar plexus, the stomach, pancreas, and termination of the duodenum, mesentery, and small intestines, the left renal and splenic veins, and the head of the vena porta; on its right side, the right semilunar ganglion and inferior vena cava, and the commencements of the thoracic duct and vena azygos; on the left side the peritoneum, as it is about to form the left lamina of the mesentery, the left semilunar ganglion, and the sympathetic nerve; posteriorly, the left lumbar veins and the four superior lumbar vertebræ, with their anterior and their intervertebral ligaments: it sends off the following branches, the phrenic, cœliac axis, superior mesenteric, inferior mesenteric, renal, suprarenal, spermatic, lumbar, and middle sacral.

The *phrenic arteries* arise in common, or near each other, from the forepart of the aorta; they both send branches to the suprarenal capsules, and to the crura of the diaphragm; the *right* ascends behind the vena cava; the *left* behind the œsophagus: on the diaphragm each divides into an external and internal branch; the former passes towards the circumference of the muscle, and inosculates with the internal mammary and the inferior intercostals; the latter encircles the central tendon, communicates with its fellow and with the phrenic branches of the mammary.

The *cœliac axis* arises from the forepart of the aorta opposite the last dorsal vertebra; it soon divides into three branches, first, the *gastric artery* ascends obliquely to the left side, to the cardiac orifice, to which and to the œsophagus it sends several branches; it then bends along the lesser curvature towards the right side, between the laminæ of the lesser omentum, and inosculates with the superior pyloric artery; it sends its branches to the anterior

and posterior surfaces of the stomach; second, *hepatic artery* ascends obliquely towards the right side, in front and to the left side of the vena porta and ductus choledochus, and in the transverse fissure of the liver divides into right and left hepatic arteries. In this course it gives off the *superior pyloric*, which passes along the upper surface of the pylorus, and joins the gastric artery; and the *gastro-duodenalis*, which descends between the pylorus and the duodenum; this gives off *inferior pyloric* branches, and divides into *pancreatico-duodenalis* and *gastro-epiploica dextra:* the former takes a curved course between the duodenum and the pancreas, sending branches to each, and inosculates with the superior mesenteric artery; the latter turns forwards, and to the left side, along the great curvature of the stomach, between it and the laminæ of the great omentum, to which, as well as to the stomach, it sends numerous branches, and inosculates with the gastro-epiploica sinistra, a branch of the splenic artery. The right and left hepatic arteries then separate and plunge into the substance of the liver, accompanying the branches of the vena porta: the right hepatic is the larger, and before it enters the gland it gives off the *cystic artery*, which supplies the parietes of the gall-bladder; third, the *splenic artery* is the longest branch of the cœliac axis; it passes backwards and to the left side, along the upper edge of the pancreas, to which it sends several branches. Near the spleen it gives off the *gastro-epiploica sinistra;* this bends forwards, and to the right side, along the great curvature of the stomach, and between the laminæ of the great omentum it inosculates with the corresponding branch from the hepatic artery. It next sends off the *vasa brevia*, five or six small branches which pass to the great end of the stomach, and inosculate with the proper gastric arteries. The splenic artery then divides into several branches, which enter the foramen on the concave surface of the spleen, and ramify through its spongy substance.

The *superior mesenteric artery* arises below the cœliac, descends obliquely forwards and to the left behind the pancreas, and over the duodenum; it then passes between the layers of the mesentery, and takes an arched course towards the right iliac fossa; from its concave side arise three branches, the *ileo-colic*, *right colic*, and *middle colic;* these three branches proceed between the laminæ of the mesocolon to the large intestine; each divides into two branches, which unite with those on either side, and form arches, from the convexities of which branches arise, some of which subdivide and unite again in the same manner as the first branches. Near this intestine straight branches proceed on the anterior and posterior surface, and supply the muscular and mucous coats; from the convex side of the mesenteric artery eighteen or twenty branches arise; these proceed between the laminæ of the mesentery, divide, and form arches, from which new branches arise; these again divide, and again unite in an arched manner: these divisions and subsequent inosculations occur three or four times before the arteries arrive at the intestine; near the latter each branch divides into two, which proceed in a direct course, one on the anterior, the other on the posterior surface of the intestine, and are distributed principally to the submucous tissue.

The *inferior mesenteric artery* arises about two inches below the preceding; it descends towards the left iliac fossa, and divides into three branches, left colic, sigmoid, and superior hæmorrhoidal; the *left colic* ascends in the left mesocolon, anastomoses with the middle colic branch of the superior mesenteric, and supplies the left part of the colon. The *sigmoid artery* is distributed to the sigmoid flexures of the colon. The *superior hæmorrhoidal* descends along the back part of the rectum, supplies the coats of this intestine, and inosculates with the middle and inferior hæmorrhoidal arteries.

The *renal arteries* arise from the sides of the aorta, between the superior and inferior mesenteric arteries; the right is longer than the left; it passes across the spine behind the vena cava; both pass behind their corresponding

vein, and divide near the kidney into five or six branches which ramify through the substance of this gland.

The *capsular arteries* are two or three in number; they arise either from the renal arteries or from the aorta; they supply the renal capsules.

The *spermatic arteries* arise from the forepart of the aorta; the left frequently arises from the renal artery; they are long and tortuous, descend obliquely outwards, crossing in front of the psoas muscle and the ureter. In the male they accompany the vas deferens of each side through the inguinal canal, and supply the testis and epididymis; in the female they pass to the ovaries, and also send branches to the Fallopian tubes, and to the sides of the uterus.

The *lumbar arteries* are four or five pair; they are analogous to the intercostal arteries, and arise from the back part of the aorta, pass obliquely outwards through the psoas, send branches between the transverse processes of the lumbar vertebræ to the muscles of the back and loins, and some also into the spinal canal, along the nerves, through the intervertebral foramina; the terminating branches are distributed to the abdominal muscles, and inosculate with the other arteries which these muscles receive from the intercostals above, the ilio-lumbar and circumflex ilii below, and the epigastric and internal mammary in front.

The *middle sacral artery* arises from the back part of the aorta, a little above the bifurcation; it descends nearly in the median line close to the sacrum, sends its branches to this bone, and communicates with the lateral sacral arteries; in direction the middle sacral, or *caudal artery*, appears as the continuation of the aorta, and such it really is in fish, and in other animals when the tail is large and posterior limbs small.

The *right and left common iliac arteries* arise and diverge from the bifurcation of the aorta, which usually occurs on a level with the lower margin of the fourth lumbar vertebra. The point of division, however, is variable, sometimes higher, sometimes lower; the angle of bifurcation varies accordingly, but it is always more open in the female, on account of the greater breadth of the sacrum; these vessels descend obliquely outwards as far as the ilio-sacral symphisis, opposite which, and resting against the psoas magnus, each divides into the internal and external iliac arteries; their length is from an inch and a half to two inches, varying of course according as the bifurcation of the aorta is high or low; in old persons they are often remarkably tortuous and irregularly dilated. As the aorta is to the left of the median line, the right iliac artery is usually considered to be a little longer than the left; the difference, however, if any, is very trifling, because the right iliac subdivides into its secondary iliac at a point somewhat nearer the vertebral column than the left does. The right and left common iliacs are covered in front and laterally by the peritoneum, which, however, is but loosely connected to them; the ureter also in general crosses them just before their subdivision, at least on the left side; but very frequently this duct has no such relation to the right, but crosses over its external iliac branch, as the trunk has subdivided nearer to the vertebral column than the line of passage of the ureter; the left iliac artery is also crossed by the inferior mesenteric. The iliac arteries in their descent pass in front of the last lumbar vertebra and its invertebral ligaments, also over the lateral branches of the middle sacral artery and the sympathetic nerve; the left is also in front of the left common iliac vein, and the right is in front of both common iliac veins. The relations, therefore, between the common iliac arteries and veins differ materially on the right and left sides; the left vein is related to both iliac arteries, it is posterior and internal to the left, but it also passes behind the right iliac artery to join the right vein, which is posterior but external to the right artery.

The *internal iliac*, or *hypogastric artery*, passes downwards, in front of the

ilio-sacral articulation, describing a curve concave forwards, reaches the superior part of the sacro-sciatic notch, when it usually, but not invariably, divides into a number of branches; from its termination a ligamentous cord (the obliterated umbilical artery of the fœtus) extends to the back and side of the bladder, ascends along this viscus, and from it to the posterior surface of the recti muscles as far as the umbilicus; it is covered by the peritoneum, and crossed near its commencement by the ureter, and in its ligamentous portion by the vas deferens; and it has posterior to it the lumbo-sacral nerve, the pyriform muscle; the internal iliac vein is also behind it, but to its outer side. The internal iliac artery gives off the following branches: ilio-lumbar, lateral sacral, hæmorrhoidal, vesical, uterine and vaginal, the glutæal, sciatic, obturator, and pudic. First, the *ilio-lumbar* arises from the back part of the internal iliac, passes outwards behind the external iliac vessels and the psoas muscle into the substance of the iliacus internus, in which it divides into ascending and descending branches. Second, the *lateral sacral* descends obliquely inwards in front of the sacral holes, through which it sends branches to the spinal nerves, also to the pyriform muscle, and to communicate with the middle sacral. Third, the *hæmorrhoidal* are two or three branches of uncertain origin; they pass to the sides of the rectum, and communicate with the superior and inferior hæmorrhoidal arteries. Fourth, the *vesical arteries* arise from the iliac or from some of its branches; they ramify on the coats of the bladder; the inferior also supply the parts about the neck of this organ. Fifth, the *uterine and vaginal arteries* either arise from the internal iliac, or from some of its branches, and are distributed as their names imply. Sixth, the *glutæal artery* passes backwards and outwards from the pelvis by the upper part of the sciatic notch, above the pyriform muscle, and divides into several branches, some of which supply the glutæus maximus, others pass forwards in a semicircular course towards the spine of the ilium, and supply the glutæus medius and minimus muscles. Seventh, the *obturator artery* passes out of the pelvis by the superior part of the thyroid hole into the upper part of the thigh, beneath the pectinæus, and divides into several branches to supply the obturator and adductor muscles. Eighth, the *sciatic artery* passes over the pyriform muscle, and escapes from the pelvis by the lower part of the sciatic notch, along with the sciatic nerve; it sends several branches to the glutæus maximus, the hamstrings, and adductor magnus; also to the small capsular muscles and to the sciatic nerve; these communicate with the circumflex and perforating arteries. Ninth, the *internal pudic artery*, smaller than the preceding, leaves the pelvis along with it below the pyriform muscle, re-enters the cavity between the sciatic ligaments, and then ascends obliquely inwards and forwards along the tuber and ramus of the ischium and ramus of the pubis, and a little below the symphysis pubis divides into two branches. In the pelvis the pudic at first gives small branches to the adjoining viscera; as it is passing round the spine of the ischium, and between the sciatic ligaments, it gives small branches to the surrounding ligaments and muscles; when it has re-entered the pelvis it gives off, First, *external hæmorrhoidal arteries*, two or three; they pass transversely to the side of the rectum and anus, and supply the integuments and muscles in that region. Second, the *perinæal artery* first descends, then turns forwards and upwards round the transversus perinæi, proceeds along the perinæum, and is distributed to the muscles and integuments in this situation, and to the scrotum. Third, *transversalis perinæi*, a small branch arising near to and often from the preceding; it takes the course of the muscle of that name, and is lost in the muscles and integuments. Fourth, *artery of the bulb* passes transversely between the layers of the triangular ligament, enters the spongy substance of the bulb, and spreads its branches through the corpus spongiosum urethræ. Fifth and sixth, *artery of the corpus cavernosum and dorsalis penis;* the former

enters and extends along the corpus cavernosum, the latter along the dorsum of the penis as far as the glans. In the female the pudic artery gives off branches to the perinæum and labia, and to the corpus cavernosum and dorsum of the clitoris, analogous to, but smaller than those in the male.

The *external iliac artery* proceeds from the common iliac downwards and outwards to Poupart's ligament, beneath which it passes, and then receives the name of femoral; it lies along the inner side of the psoas; the vein is internal and posterior, and connected to it by a thin fascia derived from the iliac. As these vessels approach the crural arch the vein advances forwards, and appears on the internal or pubic side of the artery. The external iliac artery is covered anteriorly and internally by the peritoneum, which, however, is so loosely connected to its sheath as to admit of easy separation; superiorly the ureter, and inferiorly the spermatic vessels and the genito-crural nerve, are anterior to it, and several lymphatic glands are attached to it; the termination of the ileum intestine and the vermiform appendix are in front of the right, and sigmoid coils of the colon in front of the left. This artery gives off near the groin two branches; first, *circumflexa ilii* arises from its outer side, ascends obliquely outwards as far as the crest of the ilium, where it divides into several branches, some pass to the abdominal muscles, others to the iliacus internus and quadratus lumborum, and communicate with the ilio-lumbar artery. Second, the *epigastric artery* arises from its forepart, a little above Poupart's ligament; it at first descends, then turns forwards, and ascends between the abdominal muscles and the peritoneum, crosses behind the spermatic cord, a little internal to the internal inguinal ring; about three or four inches above the pubis it enters the sheath of the rectus, divides into two branches which ascend in this muscle to the umbilicus, and which inosculate with the internal mammary artery; frequently, in place of the epigastric coming off in the manner just mentioned, a common trunk arises, which soon divides into two branches; one is the epigastric, which ascends and terminates as usual; the other, descending into the pelvis, becomes the obturator artery. The vicinity of this latter branch to the crural ring causes this irregularity to be of some importance in relation to the operation for the relief of strangulated femoral hernia.

The *femoral artery*, or the continuation of the external iliac, descends obliquely inwards from the middle of the crural arch, along the anterior and internal part of the thigh, covered superiorly by the skin, superficial fascia, inguinal glands, and fascia lata; in the middle of the thigh it is also covered by the sartorius, and beneath this by a strong aponeurosis connecting the vastus internus to the tendons of the adductor longus and magnus; at the inferior part of the middle third of the thigh, it passes obliquely backwards through a tendinous opening, bounded externally by the vastus internus, internally by the adductor magnus, superiorly by the united tendons of the adductor magnus and longus, and inferiorly by those of the adductor magnus and vastus internus; the sheath which incloses the artery and vein is very perfect, and may contribute to protect these vessels from the pressure of the surrounding muscles; the femoral artery first passes over the psoas and iliacus, next over the pectinæus and short adductor, from which it is separated by a quantity of cellular membrane and by small vessels, it next passes over the tendon of the adductor longus; the femoral vein descends along with it, at first internal, afterwards posterior to it; the anterior crural nerve is external to it, two or three of its branches are very near it; above the middle of the thigh, one small nerve crosses the artery, and the saphenus nerve descends in its sheath along the forepart of the vessel; it sends off, first, three or four superficial branches, viz:—*inguinal branches* to the inguinal glands, &c.; the *superficial pudic*, one or two in number, which pass towards the pubis and are lost in the integuments; the *superficial epigastric*, the longest

and largest of these branches, ascends obliquely inwards towards the umbilicus, parallel to the internal epigastric, and is lost in the integuments; the *external circumflex ilii* extends along Poupart's ligament to the crest of the ilium, where it terminates in the skin. Second, the *profunda* is the largest branch of the femoral, it arises about two inches below the crural arch, from the outer and back part of the femoral artery, bends a little outwards at first, then descends obliquely inwards and backwards behind the femoral artery, and the tendon of the adductor longus, passing over the psoas, cruræus, and adductor brevis; at the back part of the thigh it terminates in two branches for the hamstring muscles; in this course it gives off the two circumflex, and the three perforating branches. The *external circumflex artery* arises from the outer part of the profunda, passes transversely beneath the sartorius and rectus muscles, and divides into three fasciculi of branches, superior, middle, and inferior; the first ascend along the tensor vaginæ and glutæus medius muscles, and inosculate with the glutæal artery; the second pass round the bone to its back part, and inosculate with the glutæal, sciatic, and internal circumflex arteries; the third are the longest and largest branches, they descend towards the knee, and supply the extensor muscles. The *internal circumflex artery* arises sometimes below, sometimes above the preceding; it often proceeds from the femoral itself, it passes backwards between the psoas and pectinæus, along the obturator externus tendon, to the back part of the thigh, first sending off several branches to the surrounding muscles, and through the notch in the acetabulum to the hip joint, also some to inosculate with the obturator artery; at the back of the thigh it gives several branches to the gemelli, quadratus, glutæus maximus, and the hamstrings, and inosculates with the external circumflex and sciatic arteries. The *first*, or *superior perforating artery*, passes backwards beneath the lesser trochanter, between the pectinæus and adductor brevis, and through the adductor magnus, its branches are distributed to the latter and to the hamstrings; the *second*, or *middle perforating artery*, larger than the first, passes through the adductor brevis and magnus, and spreads its branches among the muscles on the back of the thigh; the *third*, or *inferior perforating artery*, descends behind the adductor longus, and through the magnus, to the hamstrings; on the back part of the thigh the profunda ends in two branches, one passes to the biceps, the other to the semi-membranosus.

After the origin of the profunda, the femoral gives off several small muscular and cutaneous twigs, and near the opening in the triceps, through which it passes, it gives off, third, the *anastomotica magna*, this descends in front of the adductor tendon to the knee, sends several branches to the integuments, vastus internus, and to the patella; these inosculate with the long branches of the external circumflex artery above, and with the articular arteries below.

The *popliteal artery* descends from the inner side of the femur, obliquely outwards to the inferior and central part of the popliteal space; it is covered by the skin and fascia, and overlapped superiorly by the semi-membranosus, and inferiorly by the gastrocnemius and plantaris muscles; the popliteal vein lies superficial and external to it; the sciatic nerve is still more superficial and external, and it rests upon the femur, the posterior ligament of the knee joint, and the fascia of the poplitæus muscle; its branches are, first, several muscular branches to the hamstrings and to the gastrocnemius; second, *superior articular*, encircle the lower extremity of the femur, turn round the sides, to the forepart of the joint, and communicate with the anastomotica and with branches of the external circumflex; third, *azygos-articular*, passes forwards through the posterior ligament of the joint, and supplies the synovial membrane and the adipose substance in its cavity; fourth, *inferior articular arteries*, encircle the lower part of the joint; the internal passes round the head

of the tibia, the external is beneath the external lateral ligament; these arteries pass round the joint to its forepart, inosculate with the preceding and with the anterior tibial recurrent; at the lower part of the ham the popliteal divides into the anterior and posterior tibial arteries.

The *anterior* perforates the interosseous space close to the head of the fibula, descends obliquely forwards along the interosseous membrane, and over the lower part of the tibia, the synovial membrane of the ankle, and the superior and internal part of the tarsus, to the first interosseal space; in the leg it is overlapped by the tibialis anticus internally, by the extensor communis and extensor pollicis externally; it passes beneath the annular ligament of the ankle; on the tarsus it is covered by the skin and by the internal tendon of the extensor brevis; it is accompanied by two veins; the anterior tibial nerve descends superficial and external to it; it gives off, first, the *recurrent*, which passes upwards and inwards, and is lost around the articulation of the knee, second, *muscular* branches, very numerous, to the muscles on the outer and anterior part of the leg; third, *malleolar branches*, which ramify on the external and internal malleoli; on the former they inosculate with the anterior peronæal; fourth and fifth, *tarsal* and *metatarsal*, are distributed to the bones and ligaments of the tarsus and metatarsus; between the two first metatarsal bones it divides into, sixth and seventh, the *arteria pollicis* and the *communicans;* the former supplies the integuments of the great toe; the latter the first interosseal muscles, and inosculates with the plantar arteries.

The *posterior tibial artery* descends obliquely inwards between the superficial and deep layer of muscles on the back of the leg, to the space between the heel and inner ankle, where it divides into the internal and external plantar arteries; it is covered by the gastrocnemius and solæus, and lies on the tibialis posticus, flexor communis, and inferiorly on the tibia; it is accompanied by two veins, and by the posterior tibial nerve, which lies to its external side; it gives off, first, several muscular branches to the deep and superficial muscles; second, the *peronæal artery* arises about an inch below the popliteal, descends obliquely outwards towards the external ankle, between the fibula and flexor pollicis; sends numerous branches to the muscles of the leg, and about two inches above the ankle divides into the *anterior* and *posterior perinæal* branches; the former pierces the interosseous ligament, and inosculates with the external malleolar; the latter spreads its branches on the outer side of the heel and of the foot. Between the heel and inner ankle the posterior tibial divides into the internal and external plantar; the *internal plantar* proceeds along the internal side of the sole of the foot, supplying the muscles and integuments of the great toe, and inosculating with the adjacent vessels both on the dorsum and in the sole of the foot; the *external plantar*, much larger than the preceding, passes forwards and outwards above the flexor digitorum brevis, as far as the fifth metatarsal bone: it then bends across the metatarsus, along the transversalis pedis, as far as the first metatarsal bone, where it joins the anterior tibial, and thus forms the plantar arch, from which proceed numerous muscular branches, and the digital arteries; these last arise from the anterior or convex edge of the arch, pass forwards, supplying the lumbricales and interossei muscles, and divide each into two branches to supply the opposite sides of the toes.

SECTION I.

ANATOMY OF THE VENOUS SYSTEM.

As there are two arterial systems, one for the red, the other for the black blood, so are there two venous, the pulmonary and the systemic; to these might be added as a third system, that of the vena portæ, which from its many peculiarities deserves separate consideration; it has been already described in the anatomy of the digestive organs (page 230).

The pulmonary, unlike all other veins, contain red blood; they are four in number, two for each lung; they commence in the capillaries in each pulmonary lobule, and emerge from each as a distinct branch; these successively unite with each other, and finally one vein is formed for each lobe; that from the middle lobe of the right lung joins that from the upper; the superior vein from each lung descends obliquely inwards, the inferior passes more horizontally; the four veins perforate the pericardium, and almost immediately enter the four angles of the left auricle of the heart, their anterior surface alone being invested by the serous membrane. In the lungs the venous branches accompany those of the pulmonary artery and the bronchial tubes, the latter being in the middle, the veins behind, and the arteries in front; but in the root of each lung the veins are anterior, the air tubes posterior, and the artery in the middle; the superior vena cava crosses the right pulmonary vein at a right angle: the left veins have a longer relation to the accompanying artery; although each pulmonary artery in the root of the lung has two accompanying veins, yet each branch of the former, through the lungs themselves, has but one.

The *systemic veins* are distributed through all parts of the body, and return the blood to the right auricle of the heart by three branches, viz: the coronary or cardiac, and the superior and inferior cava; the coronary vein has been already noticed (page 115). The veins are far more numerous than the arteries. for not only are the latter accompanied in all cases by one, and in most by two veins, but there is also a superficial or subcutaneous order of these vessels without any corresponding arteries. The veins may be compared to a tree, or rather to two trees; the trunk of each is the cava at the heart, the branches of one spread through all the superior portions of the body, and those of the other through the lower, but the cavæ also communicate through the vena azygos, and through the vertebral veins; the areæ of these numerous branches must greatly exceed that of each trunk, the blood, therefore, is always flowing from a wider into a narrower channel, and is thereby accelerated in its course. The veins commence in the capillary system, and are therefore continuous with the arteries; in some parts they appear to rise out of a cellular or spongy, intermediate structure; however it is most probable that the latter is but a venous plexus; from these origins the veins successively unite and form larger branches, until they finally end in two great trunks; both small and large are remarkable for their numerous anastomoses, not merely by inosculations which form a net-work, but by large branches converging and uniting either directly or by transverse communications; the deep and superficial also constantly anastomose, and large veins are often seen to divide and to unite again; in fact, the communications between veins are as free as possible, and present every variety as to form and mode, and are doubtless designed to establish free collateral circulation, which must serve as a protection against any interruption to the circulation, when the course of the blood is impeded in any one particular locality or direction. One peculiar form of anastomosis is by the formation of venous plexuses; these are developed in some parts where greater inflex of blood is occasionally

required, as around the neck of the bladder, also around the uterus, and in the spermatic cord.

Veins are composed of the same number of *tunics* as arteries, but the middle lamina is much thinner, therefore they collapse when empty or when divided; the superficial veins are thicker than the deep, and those of the lower extremity more so than those of the upper; the *external* or *cellular coat* is similar to that of arteries, only weaker, or more loose and open, but most probably slightly contractile like it; the *middle* or *fibrous coat* wants the external elastic lamina, but possesses the two other layers of organic contractile fibres, the external circular, the internal longitudinal; the *third,* or *innermost,* or *serous coat,* is stronger, but like to, and continuous with, the arterial, through the capillaries on the one hand, and through the cavities of the heart on the other; the most striking peculiarity in this tissue is the presence of numerous *semilunar folds* or *valves;* each of these is composed of a duplicature of this membrane inclosing some fibrous cords; their concave floating edge is towards the heart, and therefore the blood in its course towards this organ meets with no obstacle from these, but if impeded above them, it will press against these folds, and be supported by them, and thus a reflux will be in some measure opposed; the vein itself is dilated external to each valve, and hence, when distended, it presents a knotted and irregular appearance; these valves are sometimes in pairs, and sometimes single, and at short distances on opposite walls of the tube; they are most numerous in the extremities and in the deep veins, and are generally found at points of confluence; they are absent in the very small veins, also in the large trunks, as the cavæ, iliacs, internal jugular and innominatæ, also in the cerebral veins, and in the whole of the portal system. Sinuses are a modification of veins, they are canals lined by the venous membrane, and surrounded either by the structure of the organ in which they run. as in the uterus, and in the osseous system, or by an unyielding fibrous tissue, as the dura mater in the cranium.

In the descriptive anatomy of the veins, we divide the whole into the deep and superficial: the former are called "venæ comites," as they generally accompany the arteries, their description is, therefore, in a great measure included in that of the latter; the superficial require special attention. From the close proximity of the deep veins to the arteries, the action of the latter may afford some assistance to the circulation through the former, aided as they are by their valves, and by their free anastomoses with other deep veins as well as with the superficial.

We shall trace the veins as proceeding from the extreme parts towards the centre or towards the heart, and we shall describe them as they appear in the different regions of the body, and first:

The *veins of the head and face;* these are superficial and deep; the superficial veins of the head, return the blood from the scalp; the deep veins of the head are those of the brain with the sinuses: these, however, together with the spinal or vertebral veins, we shall postpone until we are examining the anatomy of the nervous system, as they are intimately connected with the membranes of the great nervous centre, or the cerebro-spinal axis.

The *superficial veins of the head* are the occipital, auricular, temporal, and frontal of each side; they are symmetrical or nearly so, and though superficial, are in a great degree "comites" to the arteries of the scalp, the superior and lateral regions of which contain a capillary network of vessels, especially of veins; from this plexus the occipital and auricular veins descend posteriorly, the temporal laterally, and the frontal in front.

The *occipital vein* of each side commences in numerous radicles on the back part of the scalp, accompanies the occipital artery, beneath the trapezius and splenius muscles, and joins the internal jugular vein; it receives several branches near the mastoid process, one of which communicates with the lateral sinus through the mastoid foramen.

The *auricular vein* accompanies the posterior aural artery, receives the stylo-mastoid branch, and joins the external jugular vein in the lower part of the parotid gland.

The *temporal vein* commences in a capillary network on the side and vertex of the head by anterior, middle, and posterior branches; these unite near the zygoma, and are joined by the middle temporal vein, which perforates the temporal fascia, and returns the blood from the temporal muscle; the temporal then descends between the articulation of the lower jaw and the meatus auditorius, sinks into the parotid gland, and is joined by the internal maxillary behind the neck and ramus of the lower jaw; this confluence forms a short trunk called temporo-maxillary, which forms or ends in the external jugular.

The *frontal vein* descends in the median line, sometimes double, sometimes single; the branches of these veins are expanded over the forehead, and inosculate with the temporal on each side. At the root of the nose they form a transverse arch, which joins at either end the angular vein, a branch of the ophthalmic, and the commencement of the facial; the frontal receives supra-orbital, palpebral, and nasal branches. All the veins of the scalp receive veins from the bones of the cranium, or from the diploe. The *diploic veins*, which were first described by Dupuytren, are canals or sinuses ramifying in an arborescent manner through the diploe; they are lined by the venous membrane, and have no other tunic; the osseous tissue surrounds them, with a little adipose or medullary matter. In the very young these canals are not visible, but a venous network traverses the bone: they are most developed in the old. At first each bone has its distinct sinuses, but, when the sutures are obliterated, those of one bone communicate with those of another; these sinuses open both into the external veins and into the sinuses of the dura mater: similar venous canals also exist in the long and spongy bones.

The *veins of the face* are superficial and deep; the former are *the facial* of each side: this vein commences in the angular branch of the ophthalmic, descends obliquely outwards, beneath the zygomatic muscle, passes over the lower side of the lower jaw in front of the anterior edge of the masseter, then through a groove in the submaxillary gland, and joins the internal jugular vein, first receiving the lingual, pharyngeal, and superior thyroid veins; it sometimes enters the external jugular vein, and most frequently communicates with both. On the face this vein receives numerous branches from the dorsal and lateral nasal, infra-orbital, alveolar, masseteric, buccal, coronary, or labial, &c.; it is always a large vein, and in a great measure a "comes" to the facial artery, but by no means so tortuous. The principal deep veins of the face are the ophthalmic, internal maxillary, and lingual.

The *ophthalmic vein* is lodged in the orbit; it returns the blood from the eye and its appendages, commences at the inner canthus, in the small branch, called angular, proceeds backwards along with the ophthalmic artery, but not tortuous like it; it receives several branches which correspond to those of the latter, escapes through the foramen lacerum superius, and enters the forepart of the cavernous sinus; this vein maintains a free communication between the veins of the scalp and face and the cranial sinuses.

Internal maxillary vein commences in radicles corresponding to the several branches of the internal maxillary artery; returns blood from the nose, palate, superior alveoli, pterygoid, and temporal fossæ; passes backwards and outwards internal to the neck of the jaw, where it is joined by the inferior dental and the "comites" of the meningeal or spinous artery; it then enters the parotid gland, joins the temporal, and forms the external jugular, or a short trunk named *temporo-maxillary*, which descends through the gland, and either directly becomes the external jugular, or more generally divides into two, one branch joining the latter, and the other the internal jugular, or some of its

branches. The temporo-maxillary vein is superficial to the external carotid artery in the gland; the facial nerve usually intervenes, but is sometimes anterior to the vein; it receives the transverse facial, anterior auricular, and glandular veins.

The *lingual veins* are deep and superficial; the former accompany the muscular branches of the artery, and of the ninth pair of nerves, and join the internal jugular, or a communicating branch between this and the external jugular. The ranine, or inferior superficial vein, often ends in the facial. The dorsal superficial veins form a plexus beneath the mucous membrane, branches from which extend towards the base of the tongue, join some pharyngeal and tonsillitic veins, accompany the gustatory nerve, and end in the facial or in the external jugular. The superficial veins of the neck are the external and anterior jugular; the deep veins are the internal jugular, vertebral, deep thyroid, and innominatæ.

The *external jugular vein*, or the continued temporo-maxillary, commences opposite the angle of the jaw, descends obliquely backwards to the centre of the clavicle, then turns a little forward beneath the outer border of the sterno-mastoid muscle, and enters the subclavian to the outer side of the internal jugular vein; it crosses the sterno-mastoid muscle, commencing in front, and ending behind it; its central portion is subcutaneous, and partially covered by the platisma, but above and below it is beneath the cervical fascia: its upper portion is accompanied by some of the ascending filaments of the cervical plexus of nerves; inferiorly it is superficial to the omo-hyoid and to the brachial plexus of nerves; it usually possesses one or two pair of imperfect valves, and often presents a knotted or slightly varicose appearance, and is sometimes dilated near the clavicle; it receives several branches from the side and back part of the neck, and near the clavicle the superior and posterior scapular veins; it almost always communicates above with the internal jugular, and in its course down the neck with the anterior jugular. This vein is very variable; is sometimes double, and sometimes very small; it returns the blood from the integuments, from the superficial muscles of the neck, and from the external parts of the head, and communicates freely with the internal jugular vein.

Anterior jugular vein, or superficial thyroid, commences about the os hyoides, descends near the median line along the anterior border of the sterno-mastoid, beneath the superficial cervical fascia; near the sternum it turns outwards beneath this muscle, and either joins the external jugular, or opens into the subclavian in front of or close to the internal jugular. These two anterior veins often anastomose by a transverse branch; they return the blood from the superficial parts in the anterior region of the neck, and often communicate above with the internal or external jugular, or with the facial veins. These also are very uncertain as to size; they are usually much larger below than above, and often exceed the external jugular.

The *internal jugular veins* are the channels whereby all the blood from the brain and its membranes is returned; it is also joined by several cervical branches: each commences by a dilatation at the end of the lateral sinus, in the foramen lacerum posticum; accompanies the internal, and afterwards the common carotid artery, to the lower part of the neck, and joins the subclavian to form the vena innominata of each side; it is a large vessel, but variable in this respect, and one is often larger than the other: at its commencement it is dilated; it then continues of uniform size to the os hyoides, where it is usually enlarged, as it receives a number of branches in that situation; at its junction with the subclavian it is often slightly contracted, and above this is dilated into an oval form; in its whole course it is to the outer side of the carotid arteries, but is also a little posterior to the internal carotid; the ninth, and three divisions of the eighth nerve, are to its inner side above, and the styloid process and its muscles are in front of it; lower down the lingual

and glosso-pharyngeal nerves pass forwards from between the vein and artery, and the spinal accessory nerve runs behind the vein: in the remainder of its course it is inclosed in a sheath with the common carotid, the descendens colli nerve anterior, and the sympathetic posterior to it, the pneumogastric being inclosed between and rather behind the vessels: as it descends it is overlapped by the mastoid muscle more than the artery is, which latter also it sometimes overhangs when distended; inferiorly as the carotids incline inwards, particularly the left, the veins which continue vertical are not so close to them as above; on the right side the subclavian artery and recurrent nerve separate it inferiorly from the vertebral vein; in this course it receives several branches, particularly above, viz: the lingual, pharyngeal, hyoidean, superior thyroid, occipital, &c.

The *vertebral veins* accompany the vertebral arteries only in the canal formed by the chain of foramina in the transverse processes of the cervical vertebræ, but they do not enter the cranium, neither do they correspond to these arteries in function; each commences among the deep muscles beneath the occiput, often receives a branch from the posterior condyloid hole, inosculates with the occipital vein, and enters the canal in the transverse processes, between the foramen magnum and the atlas; as it descends it receives branches from the muscles before and behind the spine and from the spinal canal, it joins the subclavian vein nearly opposite to and behind the internal jugular.

Inferior thyroid or *tracheal veins* form a plexus in front of the trachea and behind the sterno-thyriod muscles; they commence about the thyroid body, communicate freely as they descend, and open, the left into the left vena innominata, and the right sometimes into it also, or into the right vena innominata, or into the cava. These veins are frequently very large, particularly if respiration be laborious or obstructed, and they sometimes cause much embarrassment in tracheotomy.

The *venæ innominatæ* are the two large veins whose confluence forms the superior cava; situated at the lower part of the neck, and partly in the thorax; formed by the union of the subclavian and jugular of each side.

The *left vena innominata*, about three inches long, commences behind the left sterno-clavicular articulation, descends with a little obliquity to the right side, convex forwards, enters the chest and joins the right vein at nearly a right angle, below the first costal cartilage at its junction with the sternum on the right side; the left sterno-clavicular joint, the upper margin of the sternum, and the muscles and fascia attached to it, are in front of it; it covers the roots of the great branches of the aortic arch and the trachea. At its commencement it receives the thoracic duct, and in its course is joined by the left vertebral, the inferior thyroid, internal mammary, superior phrenic, and mediastinal veins.

The *right vena innominata* is fully an inch long, is formed also by the confluence of the subclavian and jugular, descends almost perpendicularly, parallel to and external to the arteria innominata; it receives at its commencement the right absorbent trunk, and in its course the right vertebral vein, and sometimes the right inferior thyroid, and right mammary and mediastinal veins.

Superior vena cava descends from the confluence of the venæ innominatæ almost vertically, but slightly convex to the right side; enters the pericardium, and opens into the right auricle behind its appendix. It is about three inches long, is related on its right side to the right lung, right pleura, and phrenic nerve; the latter becomes somewhat anterior to it; on its left side is the arch of the aorta; anterior to it is cellular membrane, the remains of the thymus gland, and a fascia; behind it are some lymphatic glands, and partly the trachea; the vena azygos joins it posteriorly just before it enters the

pericardium; within the latter it is invested in three-fourths of its circumference by the serous membrane, and lies to the right of the arch of the aorta, and in front of the right pulmonary vessels; it receives small branches from the pericardium and mediastinum, and sometimes the right thyroid, and internal mammary and right phrenic veins; it returns the blood from the supra-diaphragmatic portion of the body, and communicates with the inferior cava through the vena azygos and the vertebral veins.

Vena azygos, or *posterior thoracic*, or prelumbo-thoracic. This vein exists in the posterior mediastinum, on the right side of the dorsal vertebræ, but commences in the abdomen opposite the second lumbar vertebra, on the upper part of the right psoas muscle, from the confluence of small veins, branches of the superior lumbar, renal, capsular, and spermatic, which thus indirectly maintain a communication between it and the inferior cava; sometimes also a direct inosculation exists between this trunk and the azygos; in such cases it is usually much larger; it ascends in front of the right crus of the diaphragm, and enters the mediastinum by the aortic passage through or rather behind that muscle, along with and to the right side of the thoracic duct and aorta; it sometimes enters through the right crus with the splanchnic nerve, or external to it; in the mediastinum it ascends on the right side of the vertebral column, increasing in size, in front of the right intercostal arteries, covered closely by the right pleura; the aorta is to its left side, and the thoracic duct, imbedded in adipose tissue, is between them; the right splanchnic nerve is to its right side: opposite the fourth dorsal vertebra it arches forwards and to the right side, around and above the right pulmonary artery and bronchial tube, and opens into the back part of the superior cava, just above the reflection of the serous layer of the pericardium on that vessel. A rudiment of a valve exists at the junction; such folds exist lower down also, but it wants perfect valves. It receives several branches: in its abdominal and diaphragmatic portions, it is joined by one or two superior lumbar veins; in the thorax, by the eight inferior intercostals of the right side, and by the lesser azygos, which is formed by the union of the corresponding intercostals of the left side; some of these, however, occasionally open distinctly into the right azygos; it also receives bronchial, œsophageal, and mediastinal, variable in number and size: its convexity receives some of the right superior intercostals, either separately or by a common trunk. The first intercostal often joins the deep cervical, or the right subclavian, or vena innominata, or the cava; the latter also occasionally receives the second and third.

The *lesser*, or *left vena azygos*, arises in the abdomen, in the same manner as the right, often communicates with it, or with the inferior cava, or left renal; it enters the thorax either with and to the left side of the aorta, or through the left crus of the diaphragm, along with the left splanchnic nerve; ascends on the anterior and left aspect of the spine, crosses the seventh or eighth dorsal vertebra, behind the aorta and thoracic duct, and joins the right azygos, having received and combined into one the six or seven left inferior intercostal veins; it also receives phrenic, mediastinal, œsophageal, and bronchial branches. The intercostal veins are twelve pair, and correspond to the arteries of the same name; they commence by small branches anteriorly, where they anastomose with the mammary veins, and accompany the arteries in the groove in the lower border of each rib; near the spine they enlarge, being joined by branches from the posterior spinal muscles, which correspond to the posterior branches of the intercostal arteries; here also at each intervertebral opening they receive the spinal veins, which lead from the vertebral sinuses; the intercostal veins inosculate freely, each with that above and that below; transverse branches also pass from the right to the left, in front of the vertebræ, which, if distended by blood or injection, resemble the trans-

verse sinuses on the back of the bodies of these bones. The left superior intercostal vein joins the subclavian, or some of its branches ; the four or five succeeding either descend obliquely across the spine to join the right vena azygos, or they may unite into one trunk, called *superior vena azygos*, which may either join the right or left trunk. The varieties in these posterior thoracic veins are so many that no description can exactly conform to their condition in different individuals. The azygos veins serve to receive and return the blood from the thoracic parietes into the vena cava by a more simple and convenient arrangement than if the intercostals passed separately to the cavæ, or externally to the axillary veins; they may be considered as one very important root of the two cavæ, as they maintain numerous communications between their branches, which secure the course of the circulation, notwithstanding any local impediment in any particular vessel; they even form a loop between these two great veins, through which the blood may pass to the heart, in case the lower cava was obstructed.

The *veins of the upper extremity* are superficial and deep: the *superficial* are in general well developed, but are very variable in this respect; the principal of them are named the cephalic, basilic, and median. The superficial veins of the hand are placed on the dorsal aspect, and are thus removed from the influence of pressure; there are none of any magnitude in the palm; at the elbow they are on the anterior, or the aspect of flexion; on the back of the hand there is a venous arch, concave upwards, or rather a series of arches or loops; these receive two veins from each finger, which anastomose freely with each other and with the deep veins; from this arch branches ascend, two of which are larger and more regular, and have received distinct names, cephalic and basilic.

The *cephalic vein* commences on the outer and back part of the carpus, ascends along the radial side of the forearm to the bend of the elbow, is there joined by the median cephalic, and continues to ascend along the outer side of the biceps; near the shoulder it turns forwards, and passes towards the clavicle, between the pectoral and deltoid muscles, and then sinks deep to join the axillary vein. In the forearm this vein is accompanied by branches of the external or the musculocutaneous nerve, the larger of which generally pass posterior to it, or to the median cephalic at the bend of the elbow.

The *basilic vein* commences from the dorsal arch, near the lower end of the ulna: one branch from the little finger is named *salvatella*, the others are irregular in number and size. It ascends along the ulnar side of the forearm, passes before the internal condyle, where it is joined by the median basilic vein; it then continues to ascend along the inner side of the arm, parallel to the brachial vessels, pierces the fascia, and near the axilla joins one of the venæ comites, or the axillary vein itself; it is accompanied by the internal cutaneous nerve, which is usually superficial to it.

The *median vein* arises a little above the wrist, ascends along the middle of the forearm to the bend of the elbow; it here divides into two branches, one (median basilic) joins the basilic vein, the other (median cephalic) joins the cephalic vein; sometimes a third branch joins one of the deep veins. The median basilic is more thinly covered than the other veins, is thrown forwards by the pronator teres and the biceps, which are behind it; it lies in front of the brachial artery and median nerve; the aponeurosis of the biceps partially separates it from these; it is very often, particularly in thin persons, so close to the artery that the latter is in great danger of being wounded in venesection. The arrangement of the superficial veins in the anticubital region is very variable.

The *deep* veins accompany the brachial artery and its branches in the arm and forearm, two with each, inclosed in the same sheath; these end in the

Axillary vein, ascends in front of the artery, receives the thoracic veins,

passes beneath the clavicle, and opposite the lower edge of the first rib is named

Subclavian vein. This passes inwards, over the anterior scalenus and the phrenic nerve, and behind the clavicle and subclavius muscle; receives several veins from the shoulder and side of the neck, also the external and anterior jugular veins, and, opposite the sterno-clavicular articulation, unites with the internal jugular vein to form the *vena innominata*, which has been already described. The right and left subclavian veins do not differ from each other as the arteries do; they are both shorter than the latter, do not rise so high in the neck, and are not so much curved or arched, and, though "comites," are separated from them by the anterior scaleni muscles, and by the phrenic and pneumogastric nerves.

The veins of the lower extremity are superficial and deep; the *former* are the internal and external saphenæ. The superficial veins of the foot, like those of the hand, are placed on the dorsum, where they form an arch across the metatarsus, which receives the veins from the toes: from the inner and outer sides of this proceed the internal and external saphenæ veins.

The *external* saphena vein passes from the dorsum of the foot behind the external malleolus, ascends along the back of the leg to the ham, and joins the popliteal vein; it is accompanied by the external saphenous nerve, receives several cutaneous veins in its course, pierces the fascia of the leg, and sinks into the groove between the gastrocnemii muscles.

The *internal saphena* commences on the upper and inner part of the foot, ascends in front of the inner ankle along the inner side of the leg, and behind the internal condyle of the knee; it then inclines to the internal and anterior part of the thigh, and ascends to within about two inches of Poupart's ligament, passes through the saphenic opening in the fascia lata, and joins the femoral vein. In the thigh, branches of the anterior crural nerve accompany it, and in the leg the great or internal saphenous nerve twines around it, whose branches, separating and reuniting, inclose and encircle it: it communicates frequently with the external vein, which sometimes joins it at the knee; it also inosculates with the deep veins of the leg and thigh, and receives in the groin branches from the external parts of generation, and from the abdominal parietes, the "comites" to the superficial arteries; it is also joined by some large cutaneous branches from the front and outer side of the thigh; in this region it is straight, but in the leg it is usually tortuous and divides into branches, which separate for a short distance and join again; it is furnished with several valves; its coats are very thick, and both it and its principal branches are frequently in a varicose condition.

The *deep veins* of the leg accompany the arteries, two with each; they terminate in the following:

Popliteal vein, is very closely connected to the artery, lies posterior or superficial to it, and a little to its external side; receives the posterior saphena, the articular and numerous branches from the muscles on the back of the leg; ascending obliquely inwards, it passes through the opening in the tendons of the triceps and becomes the femoral.

Femoral vein ascends in the femoral sheath, closely adhering to the artery, posterior to it below, but internal to it above; it receives muscular branches in all its course, and frequently has one or more small collateral veins which join it at intervals; in the groin it is joined by the profunda and saphena veins.

External iliac vein, or continued femoral, extends from Poupart's ligament, on each side, to the ilio-sacral symphysis, where it meets the internal iliac to form the common iliac; is closely connected to the artery, internal to it near the pubis, but posterior to it as it ascends; near Poupart's ligament it receives the trunk of the two epigastric veins, also that of the two circumflex ilii.

Internal iliac vein accompanies the artery on its inner side; is formed by the union of several veins which accompany and correspond to the branches of the internal iliac artery, viz.: obturator, pudic, sciatic, glutæal, lateral, sacral, hæmorrhoidal, vesical, prostatic, and uterine; the hæmorrhoidal veins are named the inferior and middle, and superior, the latter are branches of the inferior mesenteric vein, which is one of the radicles of the vena porta; the inferior and middle arise from the submucous venous network about the anus and lower third of the rectum; these branches are plexiform in their course to the internal iliac and anastomose with the superior hæmorrhoidal. Several veins return the blood from the male organs of generation: those of the scrotum join the saphena or some superficial branches of the femoral vein; those of the testis are the spermatic veins, which join the cava or the renal. The veins of the penis are deep and superficial; the deep or venæ cavernosæ accompany the arteries and end in the internal pudic veins: the superficial veins commence in the prepuce, pass backwards and sink beneath the fascia, end in two or more large veins, dorsal veins of the penis; these receive branches also from the glans and corona and corpus spongiosum urethræ, proceed beneath the pubic ligament, enter the pelvis, and end in the prostatic and vesical plexus; they communicate freely with the deep veins between the crura penis, the prostate and neck of the bladder; are covered, particularly on the sides, by a venous plexus, which is supported by the reflection of the pelvic fascia; from this flexus the vesical veins carry the blood into the internal iliacs. The vagina is surrounded by a venous plexus which communicates with the vesical in front and hæmorrhoidal behind; the uterine veins are in the walls of the uterus and in the broad ligaments; they communicate with the vaginal and vesical plexus, and join the internal iliac and spermatic or ovarian veins; in the gravid uterus, these veins are greatly enlarged, and form the uterine sinuses.

Common iliac veins, are formed by the union of the internal and external, opposite each ilio-sacral symphysis; they ascend converging, and unite at an acute angle opposite the fourth intervertebral ligament, to the right side of, and a little below the division of the aorta; these veins correspond to the common iliac arteries, and are posterior to them; the left is also internal, while the right is external to its accompanying artery; their union, or the commencement of the cava, is crossed by the right iliac artery, therefore the left iliac vein is related to both left and right arteries. The left iliac receives the middle sacral vein, which corresponds to the middle sacral artery; the right does not in general receive any branch except sometimes the ilio-lumbar of that side; the left vein is larger and more oblique, the right is more vertical.

The *inferior* or *ascending vena cava* ascends along the right side of the aorta, on the right psoas and right crus of the diaphragm, separated from these by the right lumbar arteries, and right emulgent vein; superiorly it inclines to the right, enters the groove in the liver between the Spigelian and the right lobe, passes through the large quadrangular opening in the tendon of the diaphragm, to the margins of which it adheres, perforates the pericardium, bends a little towards the median line and immediately opens into the lower and back part of the right auricle; it iscovered by the peritoneum, the duodenum, pancreas, and vena porta; it receives the lumbar, spermatic or ovarian, renal and phrenic, and lastly the hepatic veins; all the veins from the other abdominal viscera enter the vena porta; the renal are its largest branches, and the cava is always dilated at their junction with it; it is also dilated at the upper part of the hepatic groove, where the hepatic veins enter it; this vein has no valves except the semilunar or Eustachian at the auricular opening.

Lumbar veins are three or four pairs; each commences by the union of

posterior or spinal, with external or abdominal branches; those of the left side are longer and pass behind the aorta, the first and second anastomose with the beginning of the azygos.

Spermatic veins pierce the tunic albuginea of the testis on the inside of the epididymis, receive branches from the latter, ascend, and form in the cord the spermatic or pampiniform plexus; from this five or six branches ascend, these diminish in number, and form but one or two, which, having passed through the internal ring, separate from the vas deferens, accompany the spermatic artery along the psoas, and enter either the cava or the renal vein; generally the right joins the cava, the left the renal vein. The *ovarian veins* return the blood from the ovaries and uterine appendages, partly also from the uterus, accompany the spermatic arteries, and terminate as in the male.

Renal or *emulgent veins* are very large, escape from the hilus of each kidney in front of the artery and ureter; the left is rather longer than the right, as it crosses the spine in front of the aorta and behind the duodenum. As the right kidney is lower down, the right vein is more oblique, the left more transverse; they each receive small branches from the surrounding cellular tissue and suprarenal bodies; the left also, frequently, the left spermatic.

The *capsular* or *suprarenal veins* open partly into the renal and partly into the cava.

The *inferior phrenic veins* follow the phrenic arteries, and open into the cava.

The *hepatic veins* commence in the portal capillary plexus; their small branches successively unite into larger, converge towards the thick edge of the liver, and escape by two sets of branches; one, small, numerous, enter the vena cava, while in the fissure; the other very large and short, only two or three, join it between the liver and the diaphragm. (*See* page 231.) The inferior cava is larger than the superior; it returns the blood from all the infra-diaphragmatic portion of the body; that is, from the inferior limbs, pelvis and abdomen, for, through the medium of the hepatic veins, it collects that which has circulated through the portal system.

This appears to me a fitting place to notice certain peculiarities in the circulatory apparatus in the fœtus; some of these have been already alluded to in the anatomy of the heart, aorta, and liver.

SECTION II.

ANATOMY OF THE FŒTAL CIRCULATION.

During uterine life, the heart passes through different stages of development, which are extremely interesting to the physiologist. At first, as in some of the inferior intervertebrata, it is unilocular, and merely a dilated and thickened portion of a simple vessel, which is venous in the lower, arterial in the upper end. It soon becomes enlarged, bent, or looped, and subdivided into two parts, an auricular and ventricular; it is then a bilocular heart, the type of the organ in fish, the lowest of the vertebrata. By degrees the ventricle becomes divided into two by a partition or septum; it is then trilocular, and represents the type of the organ in reptilia, in the several classes of which it is differently modified. A septum auricularum is next gradually developed, and the heart is then the quadrilocular organ of birds and mammalia. At birth the heart is large in proportion to the body, and more vertical or median; the two ventricles are of equal size, and descend to the apex, which is therefore rounder, and by a little dissection is made bifid, as in some

of the cetacea; there is little or no adeps on its surface, and the pericardium is semi-transparent. During uterine life, the four chambers of the heart cannot act independently, and the pulmonary circulation cannot proceed through the condensed, or, as yet, non-expanded lungs; a communication, therefore, must necessarily exist between the right and left cavities of the heart, to counterbalance this obstruction; accordingly, there are two peculiarities which are beautifully contrived, not only to suit the previous condition of existence, but also to meet the exigencies of the moment when independent life is to commence; these are, the foramen ovale, with its valve in the septum auricularum, and the ductus arteriosus or communicans between the pulmonary artery and aorta: through the former the auricles communicate, so as to form as it were but one chamber, and to constitute the heart trilocular; while the ductus arteriosus answers the same purpose as an opening in the septum ventriculorum, so that, in reality, the fœtal heart is a bilocular organ. As soon as respiration has commenced, the blood from the right ventricle is carried by the right and left branches of the pulmonary artery, which are now enlarged, into the expanding lung; the ductus arteriosus or middle branch is thereby diminished or closed, the pulmonary circulation is established, and the blood returns to the left auricle; the valve of the oval hole now closes it, and being pressed against its circumference, it soon adheres, and thus, almost in a moment, the trilocular or essentially bilocular heart is changed into the perfect quadrilocular organ. There are some other arrangements in this piece of exquisite machinery equally worthy of no-

Fig. 67.*

* The fœtal circulation. 1. The placenta. 2. The funis or umbilical cord, consisting of the umbilical vein and two umbilical arteries. 3. The umbilical vein dividing into its branches, namely, one (4) to the right lobe of the liver, one (5) to its left lobe. and one (6) the ductus venosus, which joins (7) the inferior vena cava. 7. 8. The vena porta uniting with the right hepatic branch. 9. The right auricle. 10. The left auricle; the arrow extending from 9 to 10 points out the course of the blood from the inferior cava, through the foramen ovale, into the left auricle. 11. The left ventricle. 12. The arch of the aorta, from which are given off the great branches to the head and upper extremities the blood following the course of the arrow from the left ventricle into the aorta. 13. and 14. 14. Arrows to indicate the return of the blood from the head and upper extremities, through the jugular and subclavian veins, to (15) the superior vena cava; thence into (9) the right auricle. and in the course of the arrow into (16) the right ventricle. by which it is propelled into (17) the pulmonary artery, and through (18) the ductus arteriosus into (19 19) the descending aorta. The right and left pulmonary are of small size at this period of life; they are represented cut off immediately before the commencement of the ductus arteriosus. 20. The division of the aorta into the two common iliacs. 21. The two internal iliac or hypogastric arteries becoming the umbilical arteries, by which the blood is returned from the fœtus to the placenta. 22. 22. The external iliacs, by which the lower extremities are supplied with blood. 23. The external iliac veins, which return the blood to (7) the inferior cava.

tice, and which will be better understood when the course of the umbilical vessels shall have been examined. The fœtus is connected to the placenta by the umbilical cord, which consists of one vein (umbilical) and two arteries (hypogastric or umbilical); as respects function, however, these names are ill applied, for the vein performs the office of an artery, and conveys pure or nutrient blood from the mother into the body of the child, while the arteries return from the latter to the placenta the blood which has circulated through it; the first, however, is called "vein," because it joins the venous system in the child, and the latter "arteries," because they arise from the aorta.

The *umbilical vein* arises by numerous branches from the placenta, extends along the umbilical cord, twisted round the arteries, enters at the umbilicus, ascends obliquely backwards, inclosed in the duplicature of the falciform fold, behind the linea alba and right rectus muscle; arrives at the notch in the anterior edge of the liver, proceeds backwards along the horizontal fissure, sending branches to either side, particularly to the left lobe, which at this period of life is of considerable size. Having arrived near the transverse fissure, it divides into two branches, the right or communicating, the left or the ductus venosus: the *right* is the larger, passes transversely for about an inch, and joins the trunk of the vena porta; the *left*, or the *ductus venosus*, ascends and passes backwards between the left and Spigelian lobes towards the diaphragm, and joins the middle hepatic vein just as it is about to join the vena cava. Within the latter this stream of pure blood becomes mingled with that which is returning from the lower part of the body: the lower cava then opens into the right auricle, close to and opposite the foramen ovale, and pours its blood through this into the left auricle; the Eustachian valve is in front of it, and serves not only to direct its current towards that opening, but also, in some measure, to separate or shut it off from the general cavity of the right auricle, and thus to prevent the blood of the inferior from intermingling freely with that from the superior cava; from the left auricle the blood descends into the left ventricle, is then propelled into the arch of the aorta and into its carotid and subclavian branches, to supply the neck, head, and upper extremities. As this portion of blood contains the fresh supply from the mother, it is supposed by some to account for the superior development of the head, neck, and arms, the two former containing the organs of sense and of deglutition, which are necessary to life, and the latter also are important as agents for prehension. The blood which supplies these parts is returned by corresponding veins to the superior cava, and by it to the right auricle; in this chamber it is supposed, as was already mentioned, to be kept distinct by the Eustachian valve from the blood of the inferior cava, which was directed through the foramen ovale into the left auricle; the right auricle then impels the blood of the superior cava into the right ventricle, and this into the pulmonary artery; this vessel now divides into three branches, viz., the right and left pulmonary, which are very small, and pass off laterally to each lung; and a central branch, the *ductus arteriosus*, which is very large, and about half an inch long; it arches backwards and downwards in the direction of the trunk of the pulmonary artery, and joins the descending aorta, just below the arch; through this middle branch the greater portion of the blood from the right ventricle passes directly into the aorta, and there mingles with so much of the purer blood of the left auricle and ventricle as did not enter into the carotids and subclavians; the small quantity which the right and left pulmonary branches circulate through the lungs will be returned, as in future, to the left auricle. The descending aorta proceeds as in the adult, distributes its branches to the abdominal viscera and parietes, and divides into the common iliacs; each of these again subdivides into external and internal iliacs; the external iliacs or femorals are small, and supply the lower extremities, which are by no means so fully developed as the upper, locomotion being a function only in prospect. The internal iliac,

or hypogastric or umbilical arteries, are very large; they curve forwards and upwards along the sides of the bladder to the abdominal muscles; converge, and sometimes anastomose; ascend behind the linea alba, escape by the umbilicus, enter the cord, twine round the vein, arrive at the placenta, often communicate, and then divide into numerous branches, ramify through that organ.

When birth has taken place, and the umbilical cord has been divided, and its vessels tied, the blood coagulates in these and in the ductus venosus; they become gradually contracted and impervious, and, in process of time, appear as mere fibrous cores; the right or communicating branch of the umbilical vein, however, is not closed, but continues pervious, enlarges, and becomes the left branch of the vena portæ. The foramen ovale is shut by its valve, which soon adheres to the edges; a fossa, surrounded by an annulus, always remains on its right aspect; in many cases the valve does not adhere above, but still the passage is so narrow and so oblique that no communication between the auricles exists; the ductus arteriosus also soon becomes closed and impervious, the blood being directed into each enlarged lateral channel, and the left bronchus pressing on it from below; it remains in after-life a mere ligamentous band, between the aorta and the root of the left pulmonary artery; the umbilical vein assumes the same appearance, and is named the round ligament of the liver; the obliterated umbilical arteries are called the superior ligaments of the bladder, and the remains of the ductus venosus still continue in its fissure in the liver; it is, however, often nearly removed, or rendered cellular by absorption.

The course of the fœtal circulation is considered by many to be in two distinct currents, which cross each other in the heart without intermingling there, and then branch off through the upper and lower parts of the body; these currents are likened to the figure of 8, and may be described as superior and inferior. The *superior* commences in the inferior cava, passes through the foramen ovale, the left auricle and ventricle, into the arch of the aorta, and along its carotid and subclavian branches to the neck, head and arms, and returns by the corresponding veins to the superior cava. Here the other, or *inferior current*, commences and descends through the right auricle, right ventricle, pulmonary trunk, and ductus arteriosus, into the descending aorta, to the iliac arteries, through the internal of which a large and important offset passes out of the system, while the remainder descends along the femorals to the lower extremities, and returns by the corresponding veins to the inferior cava, which receives the abdominal and hepatic veins with the ductus venosus, and ascends to the diaphragm, where this current may be supposed to end and the other to commence; or these two currents might be described as commencing and ending in the capillary systems of the upper and lower regions of the body. This theory is supported by the anatomical facts of the inferior cava facing the foramen ovale, and being connected to it by the Eustachian valve; and it is also adduced to account for the superior development of the upper parts of the body, as they are supplied from that current which is supposed to contain the fresh maternal blood. Plausible and pleasing, however, as this theory appears, some objections may be offered to it. The existence of such distinct currents is not proved, and the possibility of it may be questioned; the Eustachian valve is not competent in all cases, or during the whole of uterine life, to effect the supposed separation in the right auricle; neither is the foramen ovale as large as the inferior caval opening; it is, therefore, by no means certain that the streams from the two cavæ can be kept perfectly distinct in the right auricle. Again, to maintain the theory and the use of these separate currents, we must suppose that the arteries empty themselves at every systole, but this is certainly not the case; these vessels are always more or less full, and each ventricular contraction only

urges on a fresh wave, whose impetus extends through the whole, even through the capillary system; the arterial systole only recoils so as to restore the vessels to their former state, but not to empty them.* How, then, can distinct currents be conducted, or how can one portion of blood in the arterial system be separated or selected for one particular region? As to the superior development of the upper parts of the body, a fact which is adduced in support of this theory, it may be observed that nutrition and growth are under the influence of the nervous system, and of other and higher laws than any mechanical arrangement in the supply of blood; these functions commence and proceed on a certain and preordained scale of proportion in each part, long before any such distinct currents could have been established; and we even see in the fœtus some organs highly developed in comparison with contiguous ones, where no such explanation as difference in vascular arrangement can apply; the thymus, for example, and the suprarenal bodies. I shall not pursue this argument further by instituting any comparison between the quality of the blood in these two supposed currents, as all that has been advanced on that head is merely hypothetical. Without adopting this theory, I have always regarded the ductus arteriosus, and the foramen ovale with its valve, as simple but beautiful arrangements, not merely suited to uterine existence, but ingeniously and prospectively designed to meet the sudden change and sudden emergency that must occur at the commencement of extra-uterine or independent life. In apposition with the pericardium in the infant is the thymus body, which may next be noticed.

SECTION III.

ANATOMY OF THE THYMUS BODY.

THIS body is usually termed "gland," although it possesses no excretory duct, unless we consider the lymphatic vessels, which pass out of it, as answering that office, according to the opinion of Sir A. Cooper, who has published a beautiful and excellent monograph of this organ. It occupies the greater part of the anterior mediastinum, descends nearly to the diaphragm, in front of the pericardium, and ascends in the neck anterior to the great vessels, and on either side of the trachea as high as the thyroid body, is covered by the sternum, and sterno-hyoid and thyroid muscles; it is symmetrical, or composed of two oblong lobes, connected together by cellular tissue, but not by glandular structure, as in the thyroid body. It enlarges towards the latter periods of uterine life, and even during the first year afterwards; it then gradually decreases, and about puberty has nearly disappeared; a cellulo-adipose tissue occupies its place. It consists of a number of grains or lobules of various sizes, held together by cellular tissue, which also forms a general capsule; each contains a small cell: these cells communicate with a central reservoir in each lobe, lined by a soft, vascular membrane, on which the pores of the cells are visible; the cavity is filled with a milky, chylous fluid: its nutrient arteries are derived from the mammary and thyroid, and the veins enter the innominatæ and thyroid; the lymphatics join the large absorbent trunks near their termination in the great veins. Its function, Sir A. Cooper ingeniously supposes, is to prepare a fluid, which is like chyle, and fitted for fœtal growth before birth, and before chyle can be formed from food, and that this continues for a short period even after birth, but gradually declines as digestion becomes fully established

SECTION IV.

ANATOMY OF THE LYMPHATIC OR ABSORBENT SYSTEM.

The function of absorption is indispensable to nutrition: its agents are, the numerous minute vessels named the "absorbents," and the small, reddish bodies, through which these vessels pass, the "absorbent or conglobate lymphatic glands." The *absorbents* are divided into two classes, each named from their contents, lacteals and lymphatics. The LACTEALS are only found in the abdomen, and are so called from the milky appearance of the chyle, which they absorb from the intestinal villi, and which is conveyed by their trunk, the thoracic duct, into the general circulation, and which vessel is, therefore, the inlet for the fresh nutritive materials derived from the digestive process. The LYMPHATICS are so named from the clear fluid or lymph they contain; they are distributed through all parts of the body, and their office is to absorb in every tissue all matters that have become effete and useless; these, being first reduced to a state of solution, are conveyed into the general circulation, either to be discharged from the system by some of the excretory organs, or to undergo certain changes which will fit them again for the purposes of the economy. The lacteals and lymphatics are so similar, that they are justly regarded as forming but one system. The absorbents have been by some considered as an appendage to or extension of the venous system, and, no doubt, a close resemblance exists between veins and lymphatics: the trunks of the latter also terminate in the large veins, and the structure of each is continuous and similar; like veins, too, they have numerous valves, and, therefore, when distended, present a beaded or knotted appearance; they always accompany these vessels, both deep and superficial, and their currents are in the same direction: on the other hand, they differ from veins in passing through glands, and they continue of small size through their whole course, except in the terminating trunk, and they are less tortuous, and their valves are more numerous and perfect; except at their reticular commencement, and in their passage through the glands, they do not inosculate so freely with each other as the veins do. The exact origin of the absorbent vessels is involved in obscurity: some suppose that they commence in the several tissues, and upon all surfaces, by free open mouths; others that they are continuous with one set of terminating arteries, as the veins are with another, and that while the latter only carry black or impure blood, the former convey the colorless part of that fluid. It is most probable that in the several tissues, whether deep or superficial, they commence in a fine, reticular network of vessels, which communicate freely with each other, and that they do not commence in any part by open extremities. Neither have the lacteals open mouths, as formerly supposed, but commence by cæca in the interior of each villus; from these extremely minute origins the branches unite successively into large vessels, but with very little increase in size until they terminate in the thoracic duct. The lymphatics are arranged, like the veins, into superficial and deep: the former accompany the subcutaneous veins, the latter the deep vessels; they run very parallel to each other, often bifurcate, and either soon re-unite, or join similar adjacent branches; as they approach any of the glands, they converge, each divides into two, which inclose its extremity, and soon enter through its surfaces; these are the *vasa inferentia.* Within the gland they subdivide and inosculate, so as to form an inextricable plexus; from this branches again issue, and leave the gland by its opposite end; these are the *vasa efferentia;* they are fewer, but larger, than the inferentia. All absorbents pass through one gland at least, and

some through more, before they terminate in either of the absorbent trunks, which open into the venæ innominatæ. It has been affirmed by many that the lymphatics communicate with the veins in other situations as well as at these terminations; and this opinion is encouraged by considering the very general description of the absorbent system, and the importance of its function; also the great number of absorbent vessels compared with the small size of the two thoracic ducts. It has also been affirmed by some that the extreme radicles of the veins and lymphatics anastomose, or are continuous; and, by others, that they communicate in the lymphatic glands; also that in some situations the absorbents join large veins, such as the porta, renal, or lower cava. These statements, however, are at such variance with those of many other writers, that we must consider the question as still undetermined, and one whose true decision requires much patient investigation. The structure of absorbent vessels is very similar to, but more delicate than that of veins: they have three coats, but the middle, as in the veins, is thin, and wants the elastic lamina. The parietes of the thoracic duct are thinner than those of a vein of the same magnitude. The lymphatic or conglobate glands are very numerous both in the extremities and in the trunk; their size varies from that of a small currant to an almond; the largest are in the groin and in the roots of the lungs; in general of a pale reddish or gray color, but the bronchial are blackish, and those in the lesser or hepatic omentum are often yellowish; the color, therefore, depends on that of the matter passing through them; their form is round or oval, but many are very irregular and lobulated; they are surrounded by loose and vascular cellular tissue; each has a smooth, fibrous capsule, which is partly prolonged into it; bloodvessels penetrate it irregularly; the vasa inferentia enter at one end, and the efferentia escape at the other; within it the lymphatics subdivide, and form an intricate plexus. A section of a gland presents a cellular appearance; and some describe distinct cells into which bloodvessels and lymphatics open; this, however, is by no means certain, for such an appearance may depend merely on the divided vessels. These glands are better developed in the child; they appear redder, rounder, and more numerous, than in the adult or aged; probably in course of time, in some situations, they have become atrophied, and have been absorbed, and in others two or three have become consolidated into one.

In the descriptive anatomy of this system we shall first notice the *glands*, briefly, as they have been already spoken of in each particular region, and next the absorbent vessels. The former may be arranged into the external, and the internal or those of the cavities; the latter into the superficial and deep. In the ordinary course of dissection, few parts of the absorbent system can be demonstrated, except the two great trunks, particularly the left thoracic duct, the glands, and the larger vessels leading to and from these; but the lymphatics and lacteals generally are so small and transparent, that it is difficult to distinguish them from the surrounding tissue, unless injected, and this is by no means easy to effect; indeed to inject the lymphatic system is one of the nicest operations in anatomy; the valves will not permit the fluid being urged from trunks into branches, and the latter are so minute as almost to elude observation, and even when exposed, it is often extremely difficult and tedious to introduce and secure a pipe in them; introducing a fine-pointed glass tube containing mercury into the subcutaneous or subserous tissue may occasionally fill some of these vessels, but this coarse experiment often fails. The most certain mode is to dissect carefully beneath the skin upon the dorsum of the foot or over the inner ankle, and, having exposed one of these small vessels, to open it carefully, and introduce a fine tube; this may be repeated on several vessels; a thin and slightly anasarcous sub-

ject is the best for this purpose. Lymphatic or conglobate glands exist in the extremities, and in the trunk.

Lymphatic glands of the upper extremity.—There are none in the hand or forearm, one or two are sometimes to be found deep-seated in the hollow at the elbow-joint, and the same number also, but more superficial, above the inner condyle, near the basilic vein; a chain of separate and distinct glands accompanies the brachial vessels; in the axilla they are very numerous; several are attached to the vessels, some are scattered through the region; a small chain extends behind the lower border of the great pectoral muscle, towards the mammary gland, and another along the posterior fold of the axilla; a small group beneath the clavicle connects the brachial glands with the cervical.

Cervical lymphatic glands are superficial and deep: the former are close to the external jugular vein, along the posterior border of the sterno-mastoid muscle, and inferiorly in the space between this muscle and the trapezius, and above the clavicle; there is also in general one upon or near to the hyo-thyroid ligament. The deep cervical glands accompany the carrotid arteries, are large and many, and form a chain from the angle of the jaw to the thorax; they partly surround the great vessels, and are connected to the larynx, pharynx, œsophagus, and thyroid body, and communicate with the facial glands above and thoracic below.

Lymphatic glands of the head and face.—On the scalp there are but very few and very small; one or two behind the ear and along with the occipital artery behind the posterior border of the insertion of the sterno-mastoid muscles; there are none within the cranium; there is no reason for considering the pituitary body as of this class. On the face there are but few; one or two on the parotid gland or imbedded in it, in front of the auditory meatus; a small one in the zygomatic fossa, three or four on the buccinator muscle, a small chain along and beneath the side of the lower jaw, and a few larger attached to the lower part and deep surface of the parotid gland; often one or two lie along the facial artery on the side of the jaw.

Lymphatic glands of the lower extremity.—There are none in the foot, and but seldom any in the leg; a small one like a currant is sometimes to be found at the upper part of the interosseous ligament, and occasionally in the child a very small one exists on the tibia, a little above the inner ankle. In the popliteal space are three or four, small and round, near the vessels, enveloped in adeps, and thus obscured from view. The inguinal are numerous and clustered into three groups, two superficial and one deep; the superior superficial are small, parallel to Poupart's ligament, receive the absorbents from the external parts of generation and from the abdominal parietes; the inferior superficial are large, only two or three in number, close to the saphena vein, they receive the superficial absorbents of the extremity. The deep inguinal glands are beneath the fascia lata and close to the vessels; this chain extends upwards and inwards, beneath the crural arch, to join the external iliac glands, and one of them often occupies the femoral ring. The lymphatic glands of the trunk are those of the pelvis, abdomen, and thorax.

Lymphatic glands of the pelvis are the external and internal iliac; the external iliac form a chain along the iliac vessels, from the inguinal to the lumbar glands; the internal iliac are attached to the internal iliac vessels, extended in an imperfect chain backwards and downwards to some sacral glands, and upwards to the lumbar.

The *abdominal glands* are the most numerous: they are lumbar and visceral. The lumbar form a close chain, commencing at the common iliac vessels, and ascending around the aorta to the diaphragm; the visceral glands are those of the stomach, spleen, small and large intestine. The lymphatic glands of the stomach are small and round, situated along each curvature and around

the cardia and pylorus; those of the spleen and pancreas are attached to the splenic vein, and extend from the hilus of the former along the upper border of the latter. The glands of the small intestines form the most numerous group in the body, and are inclosed in the mesentery in the meshes of the bloodvessels; a considerable cluster exists near the duodenum, where they are often so close as to appear like a distinct gland, or a prolongation from the pancreas; they are also again connected into a cluster near the end of the ileum; the glands of the large intestine are inclosed in the mesocolon, and are few and scattered.

The *lymphatic glands of the thorax* are parietal and visceral: the parietal are, one in the posterior part of each intercostal space, near the head of each rib, and attached to the intercostal vessels; there is another set anteriorly behind the sternum, and attached to the internal mammary vessels, one for each intercostal space; there are also a few scattered through the anterior mediastinum, extending from the diaphragm, in front of the pericardium, to the root of the neck; a chain also extends through the posterior mediastinum along the œsophagus and aorta, communicating with the abdominal glands below, the cervical above, the intercostal on either side. The visceral lymphatic glands of the thorax, or the pulmonary or bronchial, are large and numerous, situated upon and below the division of the trachea, and extend along the bronchi into the pulmonary structure for some distance, and gradually diminish in size and number; those in the angle of the trachial division are the largest, and are often blended together into one mass. In the adult and old they are almost always of a dark, or even a black color; are soft, and easily broken down by slight pressure: the coloring matter is then seen to be diffused in numerous particles through their interior, and much of it, but not all, can be removed by maceration. In the fœtus and infant they are small, round, and separate, and of the same red color as glands in other situations. They have been supposed by some to be secreting glands communicating with the trachea, and the source of the dark-colored sputa so often expectorated; this opinion, however, is unfounded, as they no doubt belong to the absorbent system, and their peculiar color depends on the accumulation of the dark, carbonaceous matter brought to them by the pulmonary lymphatics. It is uncertain whether this matter consists merely of impurities from the air collected in the pulmonary cells, or whether it is a part of the excretion of the mucous surface; in either case it is taken up by the absorbents, and carried to the glands. The bronchial glands are very liable to strumous enlargement and softening, also to chronic induration, and to a deposition of calcareous matter; they may enlarge to such a degree as to interfere with the passage of the air into the lungs, or with some of the large vessels, and compress the cardiac and pneumogastric nerves. The absorbent vessels may be divided into those of the extremities and trunk; the lymphatics and lacteals of the latter we shall consider together.

Lymphatic vessels of the lower extremity are superficial and deep: the superficial commence from the toes, rise along the dorsum of the foot, and pass up the leg into two divisions, which, however, frequently communicate: one, the internal group, passes in front of the inner ankle, and keeps parallel and close to the great saphena vein; these branches ascend to the groin, enter the inferior superficial glands, and then pass through the deeper set, and through the femoral ring, into the external iliac glands. The external set of superficial lymphatics ascend behind the inner ankle, accompany the external saphena vein to the ham, pass through the glands there, and join the deep lymphatics of the limb. The deep lymphatic vessels accompany each of the deep vessels of the leg, and continue along the femoral vein to the deep inguinal glands; the inguinal lymphatics, both superficial and deep, are joined by several others, from the perinæum, from the abdominal parietes, and from

the glutæal and iliac regions; all these converge to the external iliac glands. The lymphatic vessels of the testis and ovary follow the spermatic vessels, and enter the lumbar glands, but those of the scrotum and labia pass into the inguinal glands. The lymphatics of the pelvis accompany each of the branches of the internal iliac vessels from their respective viscera, and from the sacral and internal iliac glands, converge towards the last lumbar vertebra, are joined by the femoral and external iliac lymphatics, then ascend through the lumbar glands, receiving the parietal, renal, and spermatic branches, and finally end by several large vessels in the receptaculum chyli, the beginning of the thoracic duct. The lymphatics of the abdominal viscera are very numerous, and some are very obvious. Those of the LIVER are superficial and deep. The superficial are seen all over the convex surface, through the peritoneum, and pass off in different directions; some on the upper surface of the right lobe, enter the folds of the suspensory ligament, and, conducted to the diaphragm, pass through it into the anterior mediastinum, and enter the glands there; others turn round the thin edge, enter the horizontal fissure, pass backwards to the transverse, and into the lesser omentum, and the glands situated there around the pylorus; others from the convex surface extend along the vena cava into the chest, and reach the thoracic duct; on the inferior surface of the liver also, they are very numerous, and form around the gall bladder an obvious plexus; from this surface some vessels pass to the lesser omentum, others pass round more deeply, and join some of the lower intercostal or superior lumbar glands. The deep hepatic lymphatics accompany the divisions of the porta and biliary ducts, reach the lesser omentum, pass through glands there in their course towards the spine to join the thoracic duct. The lymphatics of the stomach are in the subserous and submucous tissue: the former or superficial present a plexiform appearance beneath the peritoneum; they pass from the organ in different directions, accompanying the coronary and epiploic vessels; some pass through the glands in the lesser omentum and around the pylorus to the spine, others extend from the great curvature and extremity towards the splenic glands, and to the thoracic duct. The splenic and pancreatic vessels accompany their respective veins, and pass through the lymphatic glands before they reach the spine. The absorbent vessels of the small intestines are lymphatics and lacteals: the lymphatics arise in the subserous tissue, and the lacteals in the submucous and in the villi; the former proceed at first for some way along the tube and parallel to it, and then backwards into the mesentery and enter the glands; the lacteals at once proceed from the intestine into the mesentery and its glands; there is no reason, however, to suppose that these two orders of vessels continue distinct any longer, they enter the same glands together; neither is it certain that they are perfectly distinct even in the walls of the intestine. No doubt when the lacteals are distended with chyle, as they are occasionally found like white-beaded or knotted lines, a distinction appears, as the lymphatics are then empty, or only contain a transparent fluid, hence the latter are supposed by some to be merely connected with structural absorption or nutrition, and the former with chylous absorption alone, while the radicles of the vena porta effect the miscellaneous absorption of fluids by the simple process of endosmose; it is right, however, to add, and which I have verified by my own experience, that a successful mercurial injection of any of the intestinal absorbents equally fills the lymphatics and the lacteals. From the mesenteric glands, a fasciculus of absorbents pass in the root of the mesentery to the spine, and joins the thoracic duct. The lymphatics of the large intestine are conducted by the mesocolon through glands towards the spine; those of the cæcum and right colon join the mesenteric absorbents; those of the rectum and left colon enter the lumbar glands before they reach the thoracic duct.

Thoracic duct, great or left, is the common recipient of the absorbents, not only of all the infra-diaphragmatic portion of the body, but also of those of the left side of the chest, head, and neck, and left arm; it commences by the confluence of a variable number of branches in a common reservoir or dilatation, called *receptaculum chyli,* which is placed to the right side and somewhat behind the aorta, between it and the right crus of the diaphragm, on the body of the second lumbar vertebra; from this the duct passes into the thorax, between the aorta and the vena azygos, and ascends the posterior mediastinum in these relations, resting on the spine and imbedded in adeps as far as the fourth dorsal vertebra; it then ascends obliquely to the left, behind the aorta and to the left of the œsophagus, behind and to the inner side of the left subclavian artery; thus inferiorly it lies to the right of the aorta, but superiorly to the left; it then rises into the neck, behind the left internal jugular, and, opposite the seventh cervical vertebra, arches forwards, downwards, and a little outwards, and opens into the angle between the left subclavian and jugular veins; or a little external to this point; a pair of perfect valves protect its orifice against regurgitation from these vessels; it sometimes opens by two distinct branches, and sometimes a branch passes from it across the neck to the right subclavian vein, or to the right lymphatic duct. It is very variable as to many of these characters; sometimes there is no receptaculum, or perceptible dilatation at its origin; in its mediastinal course it is often alternately dilated and contracted, and it frequently divides into two branches, which soon reunite, or into several, which are tortuous and plexiform: in its ascending course it receives some hepatic, also the phrenic, intercostal, and pulmonic, or the thoracic lymphatics; and in the convex portion of its cervical arch it is joined by the cervical and left brachial lymphatics.

The lymphatics of the thorax are parietal and visceral: the parietal are superficial and intercostal; the former pass to the axillary and inferior cervical glands: those from the mammary glands chiefly follow the lower border of the great pectoral muscle. The intercostal lymphatics follow the intercostal veins to the posterior mediastinum, and the internal mammary veins and arteries are accompanied by the superior phrenic and anterior mediastinal lymphatics.

The pulmonary lymphatics are superficial and deep; the former appear as a network beneath the pleura, spread all over the surface; the vessels converge to the roots of the lungs, and enter the bronchial glands; the deep lymphatics accompany the bronchial tubes, also reach the same glands, join the posterior mediastinal absorbents, and enter the thoracic duct; some from the right lung occasionally join the right lymphatic duct at the root of the neck. The lymphatics of the heart accompany the coronary vessels to the arch of the aorta, and thence proceed to the bronchial glands and to the root of the neck.

Lymphatics of the head and face are superficial and deep; those of the scalp are occipital, auricular, temporal, and frontal, and accompany the corresponding bloodvessels; the two first set traverse the occipital lymphatic glands in their descent to the neck, the latter the parotidean, and the other the facial glands. The lymphatics, from the interior of the cranium, are but very few, at least but few have been discovered as yet; these vessels have been detected on the membranes of the brain, but have not been traced into the organ itself; it is, therefore, conjectured by some that the veins are the absorbing agents in the nervous centre. The cranial lymphatics that have been observed, pass out through the spinous, carotid, and posterior lacerated holes, and join the cervical system. The lymphatics of the face, both deep and superficial, accompany the several bloodvessels of this region.

The *lymphatics of the neck.*—The superficial and deep are continuous with those of the head and face, accompany the superficial and deep blood-vessels,

pass through the chains of glands, at the lower part of the neck, join the absorbents from each upper extremity, and, on the left side, end in the great, and on the right side in the lesser, lymphatic trunk.

Lymphatics of the upper extremity.—The superficial commence from the fingers and back of the hand, accompany the subcutaneous veins, are easily exposed by dissection, and, when inflamed during life, are rendered obvious by the red lines which appear through the skin; they accompany the subcutaneous veins; some follow the cephalic on the outer side of the arm, as high as the clavicle, and then sink between the pectoral and deltoid muscles to join the deep fasciculus; the others follow the basilic vein through the different glands to the axilla. The deep lymphatics of the arm follow the individual bloodvessels, reach the axillary glands, receive branches from the back part of the trunk and neck, from the mammary gland, and from the parietes of the chest. These vessels, on the left side, accompany the subclavian vein, and join the descending portion of the thoracic duct. On the right side, the axillary or subclavian lymphatics, joined by the right cervical, form a short trunk, named the *right lymphatic duct* (right thoracic duct is an incorrect term); this is scarcely an inch long; it opens into the angle between the right jugular and subclavian veins; it is the termination of the lymphatics of the right arm, right side of the thorax, and of the head and neck. This vessel is often absent, three or four branches supplying its place, and opening into the right jugular and subclavian and innominata veins.

PART III.

ANATOMY OF THE NERVOUS SYSTEM.

THIS SYSTEM MAY BE DIVIDED INTO FOUR PRINCIPAL PARTS, THE BRAIN, THE SPINAL CORD, THE NERVES, AND THE GANGLIONS.

CHAPTER I.

DISSECTION OF THE BRAIN.

SECTION I.

MEMBRANES OF THE BRAIN.

THE *nervous system* forms a very important and interesting constituent of the animal body. Upon it depend sensation, perception, and volition, as well as the effects of the latter upon the muscular system, and probably, in a great degree, muscular action generally. It is the medium through which the organs of sense make us acquainted with the external world, so as to enable us to appreciate the physical characters and properties of the various bodies that surround us. Upon it, or upon some special portion of it, depend the operations of the mind, and all those instincts, feelings, passions, and propensities, which characterize the animal creation; moreover, the organic or vital functions, digestion, absorption, respiration, circulation, secretion, nutrition, and growth, are all influenced by its agency, which regulates each, ordains their due succession, and combines these various processes into that state of harmonious action which is necessary to the manifestation and to the continuance of life. The study of these topics is the principal object of *neurology*, which implies that division of anatomical science that treats of the apparatus of *innervation* and *sensation;* this apparatus includes the organs of the senses, touch, taste, smell, sight, and hearing; the nerves with their ganglions, and the spinal cord and brain. We shall not, however, study these individually in this order, but shall defer the consideration of the organs of sense until we shall have examined the nervous system, properly so called.

The *nervous system* may be divided into two sections: one is the external or peripheral portion, and includes the numerous nerves, with their ganglions; the other is the central portion, or the cerebro-spinal axis, and consists of the spinal cord and the encephalon or brain, which is partially divided into four ganglionic masses, viz., medulla oblongata, cerebral protuberance, or mesocephale, cerebellum, and cerebrum. We shall commence with the

great nervous centre, or cerebro-spinal axis, which is inclosed in the cranium and spinal canal, and wonderfully protected from direct injury, or general concussion, by the mechanical arrangements of the osseous and ligamentous framework with which it is surrounded, and within which it is more closely invested by three membranous tunics.

The *membranes*, or *meninges of the brain and spinal cord*, are three, the dura mater, the arachnoid, and the pia mater; the first is fibrous, the second serous, and the third vascular. Although the cranial and spinal portions of these are continuous, yet, as they present peculiarities in each region, they should be examined in each distinctly.

Divide the scalp from one ear across the vertex to the other; reflect one flap over the face, the other over the back of the neck; make a circular cut with the saw through the cranium, on a level with the cartilage of the ear on each side, anteriorly about an inch above the superciliary arches, and posteriorly a little below the tubercle of the os occipitis. It is only necessary to saw through the outer table of the bones; the elevator, or a few smart strokes with the claw of the hammer, will then suffice to crack the internal table (indeed the cranium may be opened by the hammer alone; this plan, however, injures the bones so much as to leave them of little use to the student). The calvarium being now forcibly torn away, the dura mater is exposed; the latter, in some subjects, adheres so closely to the bone as to be torn along with it. This accident will injure the brain, and may be avoided by introducing the handle of the knife, or any blunt instrument, between the membrane and the bone as you gradually raise off the latter. If the student can procure two subjects, it will facilitate his study to examine the brain of both at the same time; in one dissect the parts *in situ*, and from the other remove the brain in the following manner: commencing anteriorly, gently raise it from the base of the skull, divide each nerve and vessel in succession from before backwards close to the bone, dislocate the pituitary gland from the sella Turcica, and cut through the tentorium; next divide the spinal cord as low down in the neck as you can pass the knife through the foramen magnum; then place the brain, its base upwards, in a shallow basin. Thus the different surfaces and structures of the brain, as also the several processes and sinuses of the dura mater, can be examined in continuation with each other.

The *cranial portion of the dura mater* is a fibro-serous membrane, of great strength, white, and sometimes of a bluish tint; adheres accurately to the inner surface of the skull, and effects five important purposes; first, it serves as the internal periosteum; second, as a strong covering to the brain, one very essential in early life, when the bones are separate and imperfect; third, it sends inwards folds or processes, which separate and support the principal divisions of the encephalic mass, lessen the force, and prevent the free transmission of concussions; fourth, it forms, by the separation and reunion of its laminæ, channels or sinuses with unyielding walls, lined by the venous membrane to receive the blood from the brain, and conduct it to the two internal jugular veins in the neck; and fifth, it furnishes fibrous sheaths for the several nerves as they leave the base of the cranium. Its external surface adheres so intimately to the bones, that when the latter are detached, it appears rough from the rupture of the connecting vessels and fibres; the adhesion is very close in the course of the principal sutures, and particularly in the base, where it is impossible to separate it without maceration or boiling; it also adheres to the posterior margins of the orbits, or the lesser sphenoidal wings; sends a sheath round the optic nerve to join the sclerotic coat of the eye, and is continuous with the orbital periosteum through the lacerated holes: it is firmly connected to the edge of each petrous bone, and of the foramen magnum; through the latter it is prolonged down the entire spinal canal, and it also sends processes through the several openings in the base of the skull,

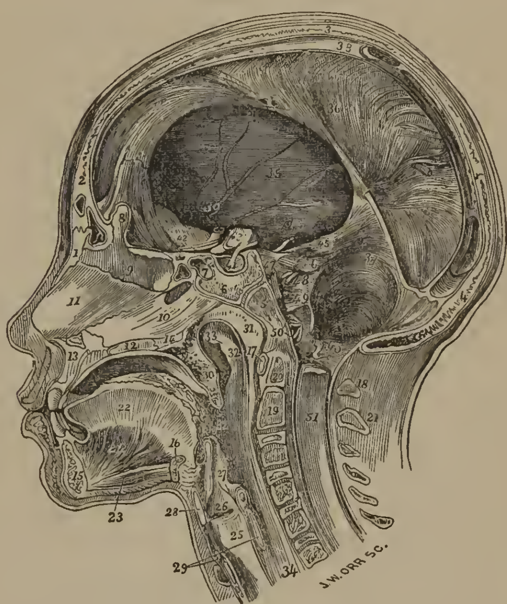
which become continuous with the external periosteum. In some situations the connection is feeble, as in the four occipital fossæ, and to the squamous and parietal bones; a blow during life occasionally detaches it from the latter, and blood may be extensively diffused upon its external surface. The degree and the mode of connection differ at different periods of life: in the aged it is so intimate that it often tears into shreds, or the bones split into laminæ, in the attempt at separation; the membrane itself becomes very thin, particularly in the base of the skull, and the attachment chiefly depends on fibres passing from the dura mater into the osseous structure, and but few vessels or red dots are seen upon its surface: in middle age the connection is partly vascular, partly fibrous, and is more easily broken; but in the very young they adhere so intimately in the lines of the sutures, that separation cannot be effected by concussion with the hammer, strong scissors or cutting forceps are required; the membrane adheres to the cartilaginous edges of the bones, and is continuous through these with the pericranium; in the base it adheres to all the temporary cartilages and sinks into all the depressions, particularly those in the petrous bones, and can only be detached by maceration. When the bones have been raised, the surface of the dura mater is found studded with numerous bloody points, the ends of the vessels that have been ruptured, and which at this age form the chief bond of union. As the cranial dura mater serves as a periosteum, it receives a more full supply of arterial blood than the spinal; its arteries ramify between it and the bone, nourish the latter, and send fine colorless capillaries to the serous lamina of the former. The anterior arteries are derived from the ophthalmic and internal carotoid; the middle or spinal artery is a branch of the internal maxillary, which, passing through the spinous hole of the sphenoid, first runs upwards and outwards, indenting the temporal and sphenoid bones, then entering a groove on the inferior angle of the parietal, which is sometimes a complete bony tube, it branches upwards and backwards on the side of the membrane between it and the bone; its posterior vessels are derived from the occipital and vertebral, and its basilar portion from the pharyngeal, vertebral, internal, carotid, and from the vessels of the bones to which it adheres. The superior veins of the dura mater enter the longitudinal and lateral sinuses, the inferior into those at the base of the skull; some communicate with the diploic veins, and those of the scalp and the middle artery have their venæ comites. This membrane in its normal state possesses but little sensibility; its nerves are small, few, and indistinct; the ganglion of the fifth pair at the base decidedly sends some filaments to it; the meningeal artery is also accompanied by fine branches from the sympathetic; the fourth, and vidian, also, are thought by some to assist in its supply. The dura mater, near the vertex, and in elderly subjects, often presents a cribriform appearance, with small, pale, granular bodies projecting from it, or rather through it, and often indenting the bone; these are named glandulæ, or more properly, corpora Pacchioni; they shall be alluded to more particularly hereafter. Cut through the dura mater on each side, raise it towards the vertex, leaving the narrow medial portion undivided; the inner surface, smooth, polished, and lubricated with serous exhalation, will now be seen; it is composed of the reflected or parietal layer of the arachnoid, adhering most closely to the fibrous membrane; this surface is always opposed to the serous surface of the brain. A portion of the dura mater may be next removed to examine its structure; this will be found to be very strong, resisting and inelastic, not unlike the sclerotic of the eye; it is fibro-serous, as the pericardium and albuginea testis; in the latter, however, the serous tissue is external; the fibrous layer consists of white fibres variously and intricately interwoven, in some situations arranged into two laminæ, as at the superior longitudinal and two lateral sinuses, the external or periosteal adhering to the bone, while the

internal separates at each side, and then reuniting incloses a triangular canal which is lined and rounded off by the venous membrane; in various other places, also, dissection may partially separate it into two laminæ, particularly in the young subject, where the external layer is more decidedly periosteal in function.

The internal folds or processes of the dura mater are the falx cerebri, falx cerebelli, tentorium cerebelli, and sphenoidal folds.

The *falx cerebri* occupies the median line, is exposed by gently separating the hemispheres of the cerebrum, or by removing one on a level with the corpus callosum; its apex commences narrow from the foramen cœcum from around the crista galli which it incloses, and from the middle ridge of the ethmoid bone, as it curves backwards, it gradually increases in depth, and its base ends in the median line of the tentorium cerebelli with which it is continuous, and which it suspends in a state of tension; its convex border corresponds to the middle ridge or groove of the frontal bone, to the sagittal

Fig. 68.*



* A vertical section of the head through the median line. 1. The os nasi. 2. The frontal bone. 3. The parietal. 4. The occipital. 5. Basilar process of the occipital. 6. Body of the sphenoid. 7. Sphenoidal sinus. 8. Crista galli of the ethmoid bone. 9. Nasal lamella of the ethmoid. 10. The vomer. 11. The median cartilage of the nose. 12. The palate plate of the superior maxillary bone. 13. The anterior palatine canal. 14. The palate bone. 15. The inferior maxillary bone. 16. Section of the body of the os hyoides. 17. Section of the anterior ring of the atlas. 18. Posterior part of same bone. 19. Body of the axis. 20. Its odontoid process. 21. Its spinous process. 22. Section of the tongue. 23. Genio-hyoid muscle. 24. Genio-hyo-glossus muscle. 25. Section of the larynx. 26. Ventricle of the larynx and vocal cords. 27. Section of the epiglottis. 28. Thyroid cartilage. 29. Cricoid cartilage. 30. The velum pendulum palati. 31. Cellular tissue behind the pharynx. 32. 32. The pharynx. 33. Orifice of the Eustachian tube. 34. The œsophagus. 35. The cavity of the cranium. 36. The falx cerebri. 37. The tentorium cerebelli. 38. The superior longitudinal sinus. 39. The internal carotid artery. 40. The vertebral artery. 41. The pituitary body. 42. The olfactory nerve. 43. The optic nerve. 44. The third or motor oculi. 45. The fourth nerve. 46. The fifth or trifacial nerve. 47. The sixth nerve. 48. The two portions of the seventh nerve. 49. The three portions of the eighth nerve. 50. The ninth or lingual nerve. 51. The medulla spinalis.

margin of the two parietals, and to the upper half of the perpendicular ridge of the occipital, and incloses the superior longitudinal sinus; the inferior or concave border corresponds to the raphe of the corpus callosum, is thicker behind, and nearly in contact with it; it incloses the inferior or lesser longitudinal sinus, which resembles an ordinary vein more than the true cranial sinuses; the base is thick and strong, and incloses the straight sinus between its laminæ and the tentorium; the course of the sinus, however, is not straight, but obliquely downwards and backwards; unlike the other sinuses, it is bounded on all sides by the fibrous tissue. The falx cerebri bisects the upper part of the cranium, separates the cerebral hemispheres, supports each in the lateral recumbent position of the body, lessens the force, and checks the transmission of lateral concussion, assists in the formation of three venous sinuses, and suspends the tentorium in the centre: it is most perfect in the young, it often becomes cribriform with age, and occasionally in the very old is partially ossified.

The *tentorium cerebelli* extends somewhat horizontally, but is higher in the centre, across the inferior part of the cranium; is exposed by raising the posterior lobes of the cerebral hemispheres: attached by its convex edge to the central tubercle of the occipital bone, and on either side to the margins of the groove on its transverse ridge, and on the inferior angle of the parietal, also to the superior internal angular ridge of the petrous bone, which is slightly grooved, and to the clinoid processes of the sphenoid: this last attachment is peculiar; the external or convex border passes like an arch over the point of the petrous bone, bounding a smooth oval passage for the fifth pair of nerves into the middle cranial fossæ, to expand into its ganglion; the internal or concave edge, or cornu, crosses over the external like the letter X, passes forwards, is inserted into the anterior clinoid process, covers the cavernous sinus, and bounds the pituitary fossa laterally; the tentorium is raised in the centre like an arch or tent, is slightly convex above at either side, and concave below, adapted to the corresponding surfaces of the cerebrum and cerebellum; it is firmly maintained in this form by the attachment of the falx cerebri to its middle line. That these processes sustain their mutual tension may be proved by the fact that the division of either immediately causes the relaxation of both. Inclosed in its convex border are two sinuses on each side, namely, posteriorly, the superior or horizontal portion of the lateral, which leaves it at the angle of the parietal bone, and anteriorly the superior petrosal, which extends along it in the groove on the angle of each petrous bone; in the median line it also forms the base of the straight sinus, the sides of which are completed by the laminæ of the falx. Anteriorly it presents a large oval opening, bounded in front by the sphenoid bone; the superior vermiform process of the cerebellum, the upper end of the pons Varolii, the crura cerebri, and the quadrigeminal bodies occupy this foramen, which lies on a plane anterior to that of the foramen magnum, and is the only communication between the upper region of the cranium and the small compartment behind and below, which is bounded by the inferior occipital fossæ, the petrous bones, the cuneiform process, and the body of the sphenoid. This compartment leads to the spinal canal through the foramen magnum. The tentorium covers the cerebellum, supports the superincumbent cerebrum, and assists in forming five sinuses, viz., two lateral, two superior petrous, and the straight: it is found perfect at all ages, never cribriform or ossified, although in some animals it is normally a plate of bone.

The *falx cerebelli* is seen when the cerebrum is removed and the tentorium divided; a small but thick vertical process, the base above attached to the tentorium, the apex bifid to each side of the foramen magnum; its convex edge adheres to the inferior occipital spine, and incloses the two occipital

sinuses; its concave edge, thick, and sometimes double, is received into the groove between the hemispheres of the cerebellum.

The *sphenoidal folds* are attached to the lesser wings of the sphenoid bone; they serve to extend the surface of the anterior fossæ in the base of the cranium, and correspond to the fissure of Sylvius. Although the cranial sinuses are a portion of the venous system, yet it is better to examine them in connection with the dura mater, which is so instrumental in their formation; they return the blood from all parts of the brain and its membranes, also from the eye, and from the bones of the cranium; they are all fibrous canals, formed externally by the dura mater, and internally by the same membrane as lines the veins generally; they communicate freely with each other, and they all terminate in the lateral sinuses, which lead into the internal jugular veins, the great channels whereby all the blood from the head is returned to the heart. There are fifteen sinuses, five of which are in pairs, and five are single or mesial; the symmetrical are, two lateral, two superior petrosal, two inferior petrosal, two occipital, and two cavernous; the azygos are, the superior logitudinal, inferior longitudinal, straight, circular, and transverse.

The *superior longitudinal sinus* commences at the crista galli, either in a *cul de sac*, or by a small vein from the nose; it extends upwards and backwards in the median line, increasing in size, and divides opposite the occipital tubercle into the right and left lateral sinuses, the right being in general the larger. With the scissors open the sinus through its whole length; its triangular form is then seen, the base towards the bone, the apex in the falx, but the angles are rounded off by the fine membrane continued from the numerous veins that open into it; it is usually dilated near the vertex; small, white, fibrous bands cross it in many places, variable in size and direction; they bear an imperfect resemblance to the valves in the veins, but cannot act as such; they may serve to resist dilatation; they have been named *cordæ Willisii*. About the middle of the sinus some of the corpora or glandulæ Pacchioni, or cerebral granulations, are generally to be observed in the adult or aged; sometimes scattered singly, often in clusters, and near the openings of the veins; in size, number, and appearance, they vary considerably; in the very young there are few, if any; in the old they are often numerous, and so large as to cause depressions in the parietal bones; they are found in three situations in the immediate vicinity of the sinus, external to the dura mater (glandulæ externæ), in the sinus (glandulæ mediæ), and internal to it about the terminations of the veins (glandulæ internæ). There is no reason for considering them as glands of any sort, neither can they act as ball-valves; we have always regarded them as abnormal, most probably the result of chronic subacute inflammation in the fine subserous tissue beneath the dura mater. As they increase, they project in different directions, some into the sinus, others separate the fibres of the dura mater, and then protrude externally; when much developed, the arachnoid around is usually thick and opaque, with cream-colored deposit; they are also sometimes found around the venæ Galeni, entering the straight sinus, also around the pineal body; and I have frequently noticed them, though of a different form, on the base of the brain, near the infudibulum and the inner extremities of the Sylvian fissures: I have not found them in the lower animals. The longitudinal sinus receives many small veins from the diploe, dura mater, and pericranium; the latter pass through the suture, or join the diploic veins, but its principal branches are the internal and superior, or external cerebral veins. The *internal*, four or five on each side, return the blood from the convolutions of the opposed surfaces of the hemispheres, and join the superior veins before they enter the sinus; some open into it distinctly. The *superior* or *external* are larger, and six or seven in number: the anterior are smaller than the posterior; one or two occasionally present a considerable size; one in particular,

which commences on the outer side of the brain, above the fissure of Sylvius they all ascend at first obliquely backwards, then curve in an arch concave forwards; others also run in this curved manner, first backwards, then forwards, and towards the median line; the largest attach themselves to the sides of the falx, beneath the reflected arachnoid, and run in the fibrous tissue for near an inch before they open into the sinus; some open free upon the sides, the orifices looking inwards; others are partially concealed by the cordæ Willisii, the greater number in a direction from before backwards, but some in the very opposite; neither the cords of Willis, nor the corpora Pacchioni, can answer as valves; neither have the veins themselves any valves. Whether the curves on the principal vessels, and their long, oblique course in the walls of the sinus before they open, together with the internal cords, may serve as some check to the reflux of the blood, are questions that have not been determined.

The *inferior longitudinal sinus* is not always present; it resembles a small vein inclosed in the lower edge of the falx near its base, receives small veins from it, and sometimes from the corpus callosum; it opens into the following:

The *straight sinus*, inclosed between the laminæ of the base of the falx and the tentorium, proceeds backwards and downwards, slightly arched, convex above, triangular, the base below; it receives the veins from the ventricles, or the venæ Galeni, which pass between the corpus callosum and tubercula quadrigemina; also inferior cerebral and superior cerebellar branches; and it ends in the confluence of the lateral and longitudinal sinuses by one, and sometimes by two openings, separated by a fibrous band; internally it presents the same fibrous or areolar appearance as the great longitudinal.

The two *lateral sinuses* are the largest of the system, and the right is usually the larger of the two; they commence opposite the occipital tubercle, from the confluence of the longitudinal and straight; each passes outwards and forwards, at first horizontally in the convexity of the tentorium, and in the horizontal groove in the occipital bone; it next indents the inferior angle of the parietal, and then bends downwards and inwards, deeply indenting the mastoid portion of the temporal bone; it then again grooves the inferior part of the occipital, and, turning forwards and rising a little, passes through the foramen lacerum posterius, and ends in the internal jugular vein: its horizontal portion is triangular, and projects beyond the bone into the tentorium; its oblique or descending portion is larger and more elliptical, but more sunk in the osseous groove; it is generally dilated at its termination; it receives inferior cerebral and cerebellar veins; many of these enter the sinus from without inwards, or contrary to the current; on the parietal angle it receives the superior petrosal sinus, also a considerable branch (mastoid vein) which passes from the scalp through a foramen near the mastoid process, or in the adjacent suture; near its termination it is joined by the inferior petrous sinus; internally these canals are smooth, and free from fibrous bands and corpora Pacchioni; they are the channels through which all the blood is returned from the brain into the general system. The following sinuses are situated at the base of the cranium:

The *cavernous sinus* on each side extends from the anterior clinoid process to the point of the petrous bone, along the side of the body of the sphenoid. The dura mater in this region divides into two layers; one is very thin, and adheres to the irregular, bony surface which bounds this space; the other is more dense, is continued across it, and contains between its fibres the third and fourth nerves, and first part of the fifth. The ophthalmic vein, having passed through the foramen lacerum orbitale superius, opens into the forepart of this sinus, and the two petrosal sinuses lead from it posteriorly to the lateral sinus; it is intersected by tendinous and membraneous bands, and presents a spongy or cellular appearance like the corpus cavernosum penis; the internal

carotid artery, and the sixth or abducens nerve, pass through it, and the lining venous membrane is reflected around these, and separates them from the blood. These sinuses inosculate through the following:

The *circular sinus*, or *sinuses*, are two small channels leading from the right to the left cavernous; one is beneath the optic commissure and before the pituitary body, the other is posterior to it, and larger; both these and the cavernous sinuses receive veins from the bones and membranes, from the pituary body, and adjacent parts of the brain.

The *petrosal sinuses* are four in number, two on each side, a superior and inferior; they lead from the cavernous sinus backwards; the superior between the tentorium and the grooved ridge of the petrous bone, and opens into the lateral opposite the inferior angle of the parietal bone; the inferior leads backwards and downwards over the suture, between the petrous and occipital bones, and ends in the lateral sinus near its termination.

The *transverse*, or *basilar sinus*, leads from one inferior petrosal sinus to th other, across the cuneiform process, and maintains a communication between the cavernous, petrous, and lateral sinuses of the opposite sides.

The *occipital sinuses* are two small canals contained in the falx cerebelli, receive veins from the cerebellum and adjacent bone and membrane, also from the vertebral canal; they sometimes extend along the sides of the foramen magnum; the blood ascends in these, as they open above into the general confluence; they are often wanting.

The *torcular Herophili* is a sort of reservoir or confluence of several sinuses, opposite the occipital tubercle, and inclosed between the laminæ of the falx and tentorium; it is somewhat oval, and presents six openings internally, viz., the lateral sinus on each side, the longitudinal above, the straight before, and the two occipital below.

The *cranial sinuses* may be regarded as veins inclosed between the laminæ of the dura mater, whereby they are not only fixed in their situation, but are also enabled to resist distension, and thus the brain is protected from any sudden or undue compression that may arise from such a cause. The free and numerous inosculations between them are also well adapted to obviate congestion of blood from any local interruption in any particular sinus, or in the veins at either side of the neck.

The second covering of the nervous centre is the arachnoid or serous membrane, which, like all membranes of this class, is a shut sac, covering the organ by one surface or lamina (the visceral), and lining the cavity or the dura mater by the other (the parietal); it is continued from the cranium through the spinal canal, and is closed inferiorly by a *cul de sac* analogous to that of the peritoneum in the pelvis; like the dura mater, it presents peculiarities in its cranial and spinal portions, which must, therefore, be examined distinctly.

Cranial arachnoid membrane presents the ordinary smooth and glistening appearance, and is of extreme delicacy; the parietal layer adheres too closely to the dura mater to admit of extensive separation by dissection; it is so transparent that the fibres of the latter shine through it; chronic inflammation thickens, and causes a deposit beneath it which renders it more evident and easy of separation; bony growths in like manner, and sometimes external injury cause ecchymosis between them; it adheres to all parts of the dura mater, except through a small space opposite the sella Turcica, where the pituitary body intervenes; the parietal layer is reflected into, or becomes continuous with the visceral at many points; thus on each side of the longitudinal sinus every vein is accompanied by a tubular prolongation of the arachnoid, which is continuous on one side with the parietal, and on the other with the cerebral lamina; in like manner each nerve is accompanied from the brain to the point of exit by a tubular process which forms a *cul de sac* at the fora-

men, and is then reflected from the nerve to the dura mater. The visceral or cerebral layer adheres very intimately in some parts, and loosely in others to the surface of the encephalic mass, or rather to the vascular membrane which covers it. On the surface of the cerebrum and cerebellum it covers all the eminences, and passes like a tense flat bridge from one to another, but does not penetrate into any of the intervening depressions or sulci; in each of these and beneath the membrane is a loose tissue, which never contains any adeps, but is often filled with serous effusion, and is easily rendered emphysematous, whereby the arachnoid can be raised distinctly, but from the surface of the eminences, it cannot be separated from the pia mater; having covered the upper part of the cerebrum, it sinks into the median fissure, and is continued from one hemisphere to the other beneath the falx; below this reflection, the opposite vascular surfaces of the hemispheres are in contact; anterior to the corpus callosum, it sinks to the under surface of the anterior lobes, beneath the olfactory lobules, which are thus confined in their sulci, covers the lower surface of the optic nerves and their commissure, passes over the pituitary body, and around the infundibulum, then over the tuber cinereum, corpora albicantia, to the pons Varolii, thus covering the depression, beneath the middle ventricle, which contains some loose and watery reddish cellular tissue traversed by fibrous bands, this is named the *anterior sub-arachnoid space;* on either side, it passes from the anterior to the middle lobes, across the Sylvian fissures, where again a space occurs beneath it at each side, *lateral sub-arachnoid space;* if we next trace it from the upper and back part of the corpus callosum, we see it passing from this to the superior vermiform process of the cerebellum, aad thence over the upper surface of this organ; another loose, cellular, fibrous space exists beneath it, between the corpus callosum and the cerebellum, *superior sub-arachnoid space;* in this situation it meets the venæ Galeni, or ventricular veins, is folded around them, and becomes continuous with the serous lining of the ventricles, as will be more fully explained hereafter; having extended over the upper surface of the cerebellum, binding its sulci close together, it passes round its circumference to its inferior aspect, and extends like a flat, tense, and strong bridge across the posterior and inferior notch between its hemispheres, and thence to the back part of the medulla oblongata, around which it is constricted; it leaves beneath it in this situation a considerable interstice (*posterior sub-arachnoid space*); from the medulla oblongata it is continued down the spinal canal, where we shall examine it hereafter; as this membrane thus covers the general outline of the encephalic mass, it leaves numerous interstices beneath it, filled by a loose, fine, areolar tissue; not merely those which are so well marked as to have received distinct names, viz., the anterior, the two lateral, the superior and posterior sub-arachnoid spaces, but also similar, only smaller ones in each of the sulci between the convolutions; the cerebral sub-arachnoid spaces communicate with each other, but not very freely, as they are filled with areolar tissue, and traversed by fibrous bands, which interrupt the transmission of the fluid; they also communicate with the spinal sub-arachnoid space, but a certain constriction in the arachnoid around the medulla oblongata restricts this also; hence, although the fluid may pass from one region to another, it does so, slowly, and a certain quantity is normally confined to each. We have already stated that the serous membrane not only covers the surface of the brain, but that it also lines the ventricles, being continued into them from the general surface. To see this process of the arachnoid membrane, separate gently the posterior lobes of the cerebrum, divide the falx, and at the anterior edge of the tentorium the two venæ Galeni will be seen entering the straight sinus; these veins are surrounded by the serous membrane; press these gently to one side, and underneath them a small round hole or canal may be observed, leading forwards below these veins, and above

the pineal body, and opening into the back part of the third ventricle; this canal is lined by the arachnoid membrane, which is continued from that on the surface of the brain, and expands within the ventricles so as to cover all the inequalities observed within them; this arrangement bears some analogy to the omental *cul de sac*, which leads into the peritonæal cavity by the foramen of Winslow; this canal is best seen in the fœtus, it is very generally partially or wholly obliterated by adhesion in the adult. That these cavities are really lined by a serous membrane, is undoubted; by carefully removing the white, fibrous neurine from the roof of either lateral ventricle, we may see this fine, delicate, transparent pellicle, but sufficiently strong to retain the fluid or air when agitated against it; so exquisitely delicate, however, is this texture, that we cannot, when these cavities are opened, raise it from their parietes to any extent; it completely lines the two lateral ventricles, being continued from one to the other beneath the fornix, through the foramen commune anterius; one *cul de sac* extends into the third ventricle and infundibulum, and another through the iter ad quartum ventriculum, which lines the latter, and closes it below; this latter *cul de sac* is so delicate, that it is often, nay usually, broken by the violence used in the dissection; some anatomists have denied its existence, and have affirmed that the ventricular fluid may always escape through the bottom of this chamber, and communicate with the sub-arachnoid space and fluid in the spinal canal, and *vice versa;* with great deference, however, to these authorities, I feel convinced that the fourth ventricle is closed inferiorly, not only by the external arachnoid, passing like a bridge from the cerebellum to the spinal cord, but also internally, and at the lower end of the calamus scriptorius, by a fine membrane with white neurine adhering to it; and I have frequently found this, particularly in children, competent to sustain water or mercury which I had dropped into the cavity from the iter or aqueduct of Sylvius above. That the internal or ventricular arachnoid is continuous with the external around the veins of Galen, or by the canal of Bichat, has been denied by some; however, repeated and careful examinations in young subjects have satisfied me that such is the case; and it is no valid objection to this account of it, that we so frequently find the canal closed or partly obliterated; an analogous change occurs in the tubular processes, between the scrotal serous membranes and the peritoneum; these were once open, serous canals, but at a very early period their sides adhere, and the original characters disappear.

As in other serous membranes, the opposed surfaces of the arachnoid are always lubricated by a fine fluid or halitus, which facilitates their gliding motion, and obviates friction; but there is also a clear fluid at all times effused beneath the arachnoid in the subserous tissue, and this is remarkably the case in the spinal region; there is more or less of this effusion in all the sulci between the convolutions of the brain, but in some instances it is scarcely to be observed; it is more abundant in the sub-arachnoid spaces at the base around the vessels, and in the sheath of the nerves, and can be well seen in a very recent brain; the superior and posterior sub-arachnoid spaces seldom retain any, probably because, as they communicate with the spinal sub-arachnoid, the fluid gravitates to it. The arachnoid and sub-arachnoid fluids are not to be confounded with each other; the former is in the arachnoid cavity, and, as in other serous cavities, is exhaled and removed by the vessels of the membrane; but the sub-arachnoid is in the subserous tissue, does not communicate with the former, and depends on the vessels of the pia mater for secretion and absorption; this appears a more reasonable explanation, than to suppose that the cerebral layer of the arachnoid is truly serous, or exhalent and absorbent on both its surfaces: some have conjectured that the arachnoid fluid may be derived from the sub-arachnoid, by permeating from the cellular tissue through the arachnoid membrane, on the principle of hygrometrical moisture, or

by endosmose and exosmose; arachnoid fluid may often be effused in abundance, and there may be little or no sub-arachnoid, and on the contrary, the arachnoid surfaces may be almost dry, and yet all the sub-arachnoid spaces gorged with fluid; lymph and purulent looking fluid are also often effused in the latter, but rarely in the former; to explain or account for this peculiarity, in the cranial and spinal serous membrane, that is, for the existence of fluid both in its serous cavity and beneath its visceral layer, we must bear in mind that the brain does not entirely fill the cranium, and also that it undergoes a constant motion; the latter is twofold, one is synchronous with the pulse, or with the systole of the ventricles of the heart, the other is an elevation and subsidence corresponding to expiration and inspiration; in expiration the veins of the neck, spinal cord, and brain are filled, and they compress the sub-arachnoid fluid, and raise the brain; in inspiration they collapse, and the organ subsides in proportion; the fluid or halitus in the serous cavity facilitates these motions by obviating friction and adhesion, while the sub-arachnoid fluid surrounds and supports the nerves and large vessels at the base of the brain, and the vessels of the pia mater over the entire surface; and as the latter is very unev n, it renders the whole smooth and regular by filling up the sulci and depressions, and thus secures and maintains uniform apposition between the parietal and visceral surfaces of the arachnoid; it must also contribute to lessen concussion or vibration from the parietes, and at the base, where it always abounds, it may be of essential service in protecting the large vessels and the nerves from the surrounding pressure. I pass over the hypothesis, that as this fluid has been found to hold in solution the nutrient elements of neurine, it may minister to the nourishment of the nervous centre.

The quantity of fluid in the sulci and sub-arachnoid spaces bears a constant ratio to the state of the organ, as if it were designed to regulate the size of the entire mass; in the very young and healthy there is little or none, except at the base; also, if the brain be hypertrophied, and its vessels full; but, whenever it becomes anemic, shrunk, small, and atrophied in whole or in parts, as sometimes occurs in very advanced age, or in idiots and lunatics, it is in considerable quantity, and often gives to the surface of the organ an anasarcous appearance; this condition is sometimes, but by no means uniformly, coincident with general anasarca; I have seen it in the anasarca that follows scarlatina: it is often sudden, and the result of inflammation. If fluid accumulate in the general arachnoid cavity, it constitutes the disease called hydrocephalus externus, and the brain is compressed; this form of dropsy is rare, though analogous to that of other serous cavities: if it collect in the ventricles, it constitutes hydrocephalus internus, a disease of more frequent occurrence, and in early life; the brain then becomes expanded, but also compressed from within by the enlargement of the cavities; in neither of these forms of dropsy, in general, is there sub-arachnoid effusion.

The *pia mater* is the next, or the third tunic of the nervous centre; it forms its immediate covering; like the two preceding membranes, it presents peculiarities in its cranial and spinal divisions.

The *cranial pia mater* is a vascular tissue of great extent and delicacy; in many parts it cannot be raised as a distinct membrane, independent of the arachnoid, which is inseparably joined to it, as on the surface of the several convolutions; but in the sulci between these, at the different fissures, and in the depressions on the base of the brain, they are perfectly distinct; it adheres to the whole surface of the brain, following every involution; it also extends into its ventricular cavities; it is intimately connected to the gray structure, by being prolonged into it; and numerous fine capillaries pass through this into the white substance, which often admit of being drawn out to a considerable length; it appears to be almost wholly composed of the nutrient vessels of the brain, which divide upon it with extreme minuteness.

The capillary arteries are remarkable for their free and obvious inosculation, and, though extremely small, admit the colored globules of the blood; from the vascular network the delicate vessels are seen to pass into the nervous substance; the capillary veins escape from it, and also ramify in this membrane, and unite into larger vessels, which finally reach some of the sinuses. All these vessels are connected together by the most delicate cellular or subserous tissue; in some situations this is strengthened by scattered fibrous bands, as at the base of the cerebrum, in the fissures of Sylvius, and below and behind the cerebellum. In the spinal portion, as we shall see hereafter, this fibrous element abounds. In the sulci, between the convolutions, by injecting air or any fine fluid beneath the arachnoid, we can separate these membranes to some extent; the serous will then be seen to pass from one eminence to another, while the vascular sinks to the lowest part of the fissure, descending on one side and ascending on the other; by a little care it may be drawn out and unfolded. We may thus infer the vast extent of its surface; how much greater than that of the arachnoid, and how it exactly represents the superficies of the gray coating of the cerebrum, supposing it were possible to unfold the latter, and expand its involuted surface into a level plane. On the cerebellum it is arranged in a similar manner; it not only covers its whole surface, as the arachnoid does, but it sinks in between its numerous plates, and its double laminæ line all the grooves and fissures, primary and secondary, which penetrate that organ; it is even more delicate, and, therefore, more difficult to separate from the arachnoid, and from the nervous tissue on it, than upon the cerebrum; from the latter it may be torn, or jerked off with the forceps, without injury to the surface, but on the latter it is too fine and weak to admit of this experiment.

In each Sylvian fissure, and in the central cerebral depression, as well as in the other sub-arachnoid spaces, the pia mater may be easily detached from both surfaces, and affords a good opportunity for the examination of its capillaries. From the surface of the brain it is prolonged into the ventricles, and forms remarkable processes in these cavities; these may be considered as only two in number, but, according to some, as five: thus, at the back of the medulla oblongata, between it and the inferior vermiform process of the cerebellum, a fold of pia mater is pushed into the fourth ventricle, from below upwards. This is considered by some as double, one on either side, but they are really united in the median line; this is the choroid plexus of the fourth ventricle; the other, the great internal prolongation, enters the transverse fissure in the cerebrum, and is divided by anatomists into three parts; its middle portion is called the velum interpositum, because it is interposed between the third ventricle, which is beneath it, and the fornix and corpus callosum, which are above it; its lateral portions are named the choroid plexuses; but these are united by the velum, and really constitute but one fold. The transverse fissure extends from the inferior and internal part of the middle lobe of the cerebrum on one side to the same point on the opposite; commencing between the middle lobe and the crus cerebri, it leads upwards and backwards external to the tractus opticus and optic thalamus, then bends transversely across the median line, in front of the cerebellum and of the tubercula quadrigemina, and behind and beneath the fornix and the posterior bent end of the corpus callosum, and then inclines downwards and forwards on the opposite side. In the lower and anterior part of this fissure, on each side, the choroid fold or plexus enters into the inferior portion of the lateral ventricle, passes first upwards and backwards, then bends forwards and inwards through the middle portion or body of each ventricle, and those of opposite sides, converging in front, become continuous in the foramen commune anterius, beneath the anterior pillars of the fornix; both are also united in the median line, beneath this body, with the velum. Each plexus appears to

be a compressed fold of the vascular membrane, which frequently admits of being expanded into a beautiful, delicate, vascular web, with numerous tortuous capillary arteries, and one or two veins bordering it, which it receives from the corpora striata; these veins finally end in the venæ Galeni; each plexus hangs loose into the cavity, and can be pushed to either side, but is attached to the margin of the fissure by the fine serous membrane of the cavity being reflected over it; this adhesion is very distinct in the line of the fissure, but the reflected membrane is too delicate to admit of demonstration over the web itself. When the plexus is removed, and carefully examined, it is found to present projections or folds like the placental tufts or the villous processes of the chorion—these are plexuses of small vessels; the whole surface is covered with a fine epithelium like that of serous membranes. There is every reason, therefore, to suppose that each plexus is but a fold of pia mater pushed into the ventricles through the cerebral fissure, and carrying before it an inflection of the lining serous membrane of the cavity. The fissure is thus closed internally, while externally the arachnoid membrane, in passing from one eminence to another, also attaches its margins. The velum interpositum connects one plexus with the other, is thin and transparent, and in some parts so weak as to give way under examination; of a triangular form, its base is posteriorly, in the fissure between the quadrigeminal bodies and the corpus callosum; to its lateral borders the chorid plexuses are attached; its apex is in the foramen commune anterius. A number of veins from the corpora striata, optic thalami, and septum lucidum, join it at this point, and commence the venæ Galeni; these proceed backwards in the median line of the velum to the straight sinus; its upper surface is covered by the fornix and corpus callosum, and it lies over the optic thalami and the third or median ventricle; on raising it anteriorly, and drawing it gently backwards, we rupture numerous vessels passing to and from the optic thalami, and near its base two laminæ descend to form a capsule for the pineal body; between these laminæ, and above this body, is the anterior extremity of that tubular prolongation of the serous membrane which is continued from the external surface, around the venæ Galeni, into the upper and back part of the third ventricle, and is thence expanded and continued over the whole of the ventricular surface. The velum and choroid plexuses will be again alluded to in the dissection of the lateral ventricles; it will be then seen that these three are but one vasculo-membraneous expansion or fold prolonged from the external surface to cover and convey bloodvessels to and from the internal; this fold carries before it the serous membrane of the cavities; it must, therefore, be composed of four laminæ, viz., the two serous, inclosing the double vascular fold, while again the whole extent of the transverse cerebral fissure is closed externally by the arachnoid passing from one side or eminence to the other, except around the venæ Galeni, where it is prolonged inwards in the tubular manner described. A simple mode of regarding the transverse fissure, velum, and choroid plexuses, is to suppose that the floor of the lateral ventricle was, in an early stage of development, the surface or summit of the brain, and was then covered by the vascular and serous membranes; but as the crura cerebri extend upwards, and the hemispheres enlarge, the latter come to conceal what was the surface, and to overlap it both before and behind, as well as internally, externally, and inferiorly, and the margins of this overlapping portion are attached to the root, or to the crus cerebri, by the arachnoid membrane passing across the fissure, and adhering to either side.

There are two modes of dissecting the encephalic mass; one consists in examining it from above downwards, by removing it in successive slices; the other proceeds from below upwards, and consists in unravelling its structure by tracing the columns or fasciculi of the spinal coid as they radiate, expand,

and enlarge in the cranium. We shall commence with the first, whereby the student can become acquainted with the descriptive anatomy of each part, its situation, relation, and form, which knowledge is necessary before he can pursue the other course, or that from below upwards, whereby he can unravel the structure, and trace the connection, relation, and dependence between one part and another, though at a distance. This latter mode is the most physiological or natural, because it attempts to follow the order of succession, in which the several divisions of the encephalon are first developed in the embryo, as also to explain the relative importance of each as they are first found in the different classes of vertebral animals, what parts are primary or essential, and what are superadded. Thus the spinal cord exists in all vertebrata, put the other parts are only gradually added as we rise in the animal scale from the lowest to the highest. In the lowest some parts are totally absent, or only rudimentary; but as we ascend from fish through reptiles, birds, and mammals, either new organs are superadded at every stage, or the original become more complex in structure. With a view to pathological investigation, the first-mentioned course of dissection is indispensable.

Before we enter on the minute examination of the nervous centre, we should consider the nature of the materials of which it is principally composed. A section of almost any portion of the cerebro-spinal axis exhibits two species of nervous matter, or neurine, one gray, the other white; the gray neurine covers the cerebrum and cerebellum, and has, therefore, been termed "cortical," but incorrectly, for it is also placed internally in many situations, as in the corpora striata, optic thalami, and tubercula quadrigemina, and in the spinal cord it is altogether inclosed in the white. The white neurine, also called "medullary substance," is not only a large constituent of the nervous centre, but is also the chief element of the nerves, and always presents a fibrous structure, much more distinct, however, in some parts than in others: these two substances differ essentially.

The *gray neurine* appears in two forms, first, as a thin lamina, about the eighth of an inch in thickness, over the entire surface of the cerebrum and cerebellum, convoluted or involuted on the former, and folded into laminæ or plaits upon the latter; and, secondly, as distinct ganglionic masses, such as the corpora striata and optic thalami; it is very soft, and breaks down, under slight pressure, into minute granules, which are entangled in vascular shreds from the pia mater. The microscope has revealed that these granules are vesicles or cells with nuclei and nucleoli; that they are imbedded in a granular substance, and that they differ in form and size in different situations; in general they are globular, and composed of a transparent, membranous covering, filled with soft, granular matter, on which the color depends. Adhering to some part of this vesicle is the nucleus, and apparently similar in structure; within the latter is the small, transparent nucleolus: among the vesicles, in different situations, are pigmentary particles, on which, as well, probably, as on varying degrees of vascularity, depends the peculiar shade of color in certain parts: though the vesicles are usually globular, yet some deviate from this form, and have projections or caudate processes of variable length. Among the globules in the gray neurine we also find a number of the white nervous fibres. Gray neurine is the most vascular portion of the nervous system, and is regarded by the physiologist as the scource of nervous power, or the great dynamic agent in the function of innervation.

The *white neurine* always presents a fibrous appearance, both in the nerves and in the nervous centre; in the former it is alone, but in the latter is combined more or less with the gray. The fibres are tubes disposed in fasciculi, which are usually straight; some occasionally appear varicose, but this probably is owing to accidental pressure; the diameter of a tube is said to vary from $\frac{1}{5000}$ to $\frac{1}{14000}$ part of an inch; each consists of a fine, transparent

membrane or neurilemma, containing a soft or semifluid substance. After death this soon becomes more compact, and then presents an opaque, white appearance. In the nerves these fibres are bound together by areolar tissue, but in the nervous centre none of this can be observed, excepting, that most minute portion which accompanies the fine bloodvessels that are scattered through it. The white neurine greatly exceeds in quantity the gray, as the greater portion of the brain and spinal cord, and all the nerves, are composed of it. The mode in which the two extremities of the white fibres terminate is not perfectly ascertained in every texture; in some it is obvious, and, resting on analogy, it is very generally admitted that, in the gray neurine in the centre, they end in loops or in plexuses, and at their peripheral extremities in loops also. White neurine is considered to differ from gray in function, and to be only internuncial or conducting, the medium for transmitting impressions to the sensorium, and of conveying from the latter the stimulus of volition to the muscles, as also of uniting different and distant nerves, and different portions of the nervous centre; the fibres which minister to the first of these offices are termed *afferent*, to the second *efferent*, and the third are *commissural* or uniting. The encephalic mass consists of four portions, which are not, however, perfectly separate; first, the cerebrum, which occupies all the upper, lateral, and anterior regions of the cranium; second, the cerebellum, lodged in the inferior occipital fossæ: third, the cerebral protuberance, or mesocephale, resting on the cuneiform process and body of the sphenoid bone, nearly in the centre of the base of the skull; and, fourth, the medulla oblongata, which corresponds to the foramen magnum and atlanto-occipital space. No accurate line distinguishes this from the spinal cord.

SECTION II.

DISSECTION OF THE CEREBRUM.

The cerebrum is the largest part of the brain, and larger in man than in any other animal; of an oval figure, the larger end posteriorly, the longest transverse diameter corresponds to a line from one mastoid process to the other; a little flattened on the sides, convex above, and divided into two symmetrical portions, the right and left hemispheres, by a deep median fissure; this fissure is continued before and behind through the entire depth of the cerebrum; descends anteriorly to the base of the cranium, and posteriorly to the tentorium, but in the middle is interrupted by the corpus callosum; it contains the anterior cerebral arteries and veins, and the falx, beneath which the inner surfaces of the hemispheres are in contact; each hemisphere is convex superiorly and externally, flat internally, or towards the falx; inferiorly very irregular and uneven; the surface, smooth and polished from the arachnoid covering, is everywhere marked by a number of eminences, termed *the convolutions of the brain*, from being convoluted somewhat like the intestines; these are of various size and shape; their round edges are separated by fissures or sulci, which take different directions, serpentine, longitudinal, and oblique.

The convolutions are so varied as almost to defy individual description, indeed neither their form nor number can be accurately defined, for each runs into the other at some one part, and though at first view distinct, they really are not so; there is a close, but not in all cases a perfect, symmetry between those of opposite hemispheres; each is nearly surrounded by a narrow sulcus or sub-arachnoid space; this becomes very distinct in cases of atrophy of the

convolutions or of subserous effusion; some are depressed, others marked by lines or subdivisions; the sulci also vary, some are an inch and a half, and some only a quarter of an inch in depth. A convolution is a convex fold of superficial gray neurine, covered all round to its base by pia mater; a sulcus is a depression or involution between any two or more convolutions, and is lined by a continuation of the gray lamina; in the structure or thickness of the latter, there appears no difference either in the sulcus or on the convolution; the gray neurine, therefore, forms, all over the cerebrum, two series of folds or processes, one are convolutions, convex externally, and concave internally; the other are involutions, concave externally, and convex internally; the white fibres are inserted into every point of the internal surface of the gray coating; some fibres, therefore, must be longer than others, those, for instance, which are inserted into the concavity of an eminence, than those which only reach the convexity of a sulcus: we may suppose that the white fasciculi radiating from within are, some long, others short, some thick, others thin, and that all are to be capped or coated over by a lamina of gray neurine of nearly uniform thickness; the latter, therefore, must present a convexity where it is expanded over long or thick fasciculi, and a concavity where it is involuted or depressed in order to reach shorter or smaller bundles.

Some convolutions are more uniformly present than others, and exist in the lower animals; such are named primary: others are in a great measure offsets from these, and are called secondary. The direction of both is variable, but the latter are mostly transverse, and the former from before backwards. Of the primary convolutions one of the most regular is that long curved one on the inner side of each hemisphere, above the corpus callosum, from which it is separated by a narrow sulcus; this, having some resemblance to a hem or selvidge around the edge of the hemisphere, has been named the "ourlet" or hem-like convolution. Smaller convolutions branch upwards from its central portion. Anteriorly it bends down like the corpus callosum, and is lost in some of the inferior convolutions near the Sylvian fissure; posteriorly it also follows the corpus callosum, is connected to some posterior convolutions, and then bends downwards and forwards in the middle lobe, external to the transverse fissure, and forms the hippocampus major and its foot-like expansion. The fissure of Sylvius separates its extremities; it contains a fasciculus of white fibres which take a peculiar direction, that is, parallel to the convolutions, and is named *superior longitudinal commissure.* On the under surface of each anterior lobe are two long but small convolutions bounding the sulcus which lodges the olfactory lobe. A large convolution bounds the Sylvian fissure, and is connected to those before and behind, and at the bottom of this fissure is that very remarkable cluster of radiated convolutions, known by the name of the "island of Reil;" the fissure itself is a great involution of the gray lamina, and its whole surface is wonderfully extended by complex convolutions and indentations. The convex surface of each hemisphere presents several convolutions: those on the occipital lobe are the smallest, the largest correspond to the parietal bones, and the anterior are of a median size; the sulci are principally vertical, and obliquely transverse; a convolution on the inner side of the posterior lobes extending backwards, corresponds to the hippocampus minor in the posterior crus of each lateral ventricle. There are no convolutions in the brain of fish, reptiles, or birds; they first appear in the rodentia among mammalia, and only in certain members of that class, and in them are merely rudimental; they are decidedly developed in the carnivora, and still more so in the ruminantia; in the elephant, and in some of the cetacea, they are very numerous; in the porpoise and dolphin they are small, and as numerous as in man, but I find the sulci and involutions are very shallow, so that the vesicular lamina is not at all so extended as might be at first supposed; in the quadrumana the convolutions are inferior in number and size to

those in the elephant or porpoise, but the sulci and involutions are deeper, and the whole organ, especially the occipital lobes, bears a greater resemblance to that in man, except in point of size. In man they are more symmetrical and uniform, and the sulci and involutions are better marked, than in any other animal, therefore, in him the vesicular layer is most extensive. In the fœtus at birth, and more so previously, the convolutions, though all present, are not so distinct, the sulci are not so deep, and the involutions are scarcely developed. If the brain of the fœtus and that of the adult be contrasted, a striking difference will be observed, not only in respect to the convolutions, sulci, and involutions, but also in the investing gray lamina, which is much thinner and paler in the former than in the latter.

A section of either hemisphere clearly displays this convoluted and involuted arrangement of the vesicular or gray neurine, the mechanical effect of which must be threefold: first, to increase the superficial extent of the vesicular or gray lamina; second, to extend that of the pia mater, or vascular nutrient tissue, in the same degree; and third, to enable a greater quantity and number of white or conducting fibres to come into contact with the vesicular matter than could possibly be the case, if the latter, in the confined area of the skull, presented one smooth, uniform expansion, as is the case in the more simple brain of the inferior animals. The physiological design of this formation is a problem still involved in mystery; different opinions are entertained respecting it; some maintain that as the gray neurine is the most highly organized portion of the nervous system, it is the most influential in the function of innervation, that it is, in fact, the principal dynamic agent in this function, and that the greater the extent of this substance, *cæteris paribus,* the greater will be the capability of manifesting nervous power. Now this convoluted arrangement of this material has the obvious effect of collecting into a small space a great superficial extent, whereby the greatest possibile number of white fibres are brought into contact and communication with it. Others, who maintain the analogy between the phenomena of electricity and those of the nervous system, consider that, as the electric force is proportioned, not to the quantity of the mass concerned in its production, but rather to the extent of its surface, so the energy of nervous action will be in proportion to the superficial extent of the gray or dynamic neurine, and to the number of connecting points between it and the white or the conducting fibres. It is very generally believed, and certainly with great reason, that, as the convolutions and the hemispheres are more highly developed in man than in any other animal, his mental and intellectual superiority is connected with their existence; that, in fact, the convoluted surface of cerebral gray neurine is the seat of intellectual action. This opinion is confirmed by comparative anatomy, by contrasting this surface in the male and female, in the child, in the adult, and, again, in the very aged, and in different persons whose intellectual powers had been known, and could have been compared during life; also in the idiot, the lunatic, or diseased; also by observing that inflammation of this surface, or of its vascular membrane, disturbs all mental operations, and even induces delirium. This opinion is carried still further by the phrenological school, whose supporters insist on two distinct propositions: first, that there exists a plurality of mental functions, or certain distinct fundamental faculties, moral feelings, and propensities; and secondly, that the cerebral convolutions are the organs or material instruments by which those functions are performed; and they accordingly mark upon the skull numbers corresponding to certain convolutions or mental organs within. The first proposition is purely metaphysical, and may or may not be true; its consideration does not fall within our province: the second rests not merely on the universally admitted opinion that the convoluted surface is the seat of intellectual operation, but mainly on the frequently observed and very re-

markable coincidences between certain high mental manifestations and great development of the corresponding convolutions. To this theory it has been objected, first, that not only is the gray neurine one continuous and unbroken surface, without any structural distinction or division between its various eminences and depressions, but the white fibres also appear combined into one uniform mass; secondly, that several convolutions are not recognized, though in point of size and uniformity of existence they would appear superior to those which have been stamped with numbers, for example, the "ourlet," the "Sylvian," the convolutions of Reil, and many at the base; thirdly, that the apparent fulness or obvious prominence of some eminences may depend, not on any superior development in them, but rather on a protrusion of others which are contiguous or deeper seated; thus a highly developed "ourlet" might account for an elevation of the vertical and parietal convolutions, &c. &c.; fourthly, no precise function can be assigned to the involuted or depressed convolutions, whereas if the dynamic power of the whole organ, or of individual portions, be in a ratio to the superficies of the gray lamina, then this series of involutions, or depressed convolutions, must be equal in function and importance to the convex eminences, inasmuch as the combined areæ of the former exceed that of the latter; neither are convolutions and involutions always in the same ratio; the latter may be deep, and even expanded below, when the convolutions are by no means prominent, and *vice versa*. Therefore, mere inspection of the convex surface of the cerebrum cannot enable us to judge of the superficial extent of the gray or vesicular lamina. We may see a large brain, with full and well-developed convolutions, but with shallow involutions, and, on the other hand, we may see a small brain, with moderately developed convolutions, but deeply prolonged involutions; in the latter case we shall probably have an equal extent of superficial area of vesicular neurine, and, therefore, an equally dynamic organ and energetic brain, as in the former, all other conditions as to temperament, health, &c., being supposed equal; fifthly, in the fully formed skull the internal surface of the bones is marked by depressions which correspond to the convolutions, and by intervening ridges or prominences corresponding to the sulci; so that from an internal mould of the cranium a very accurate representation of all the surface of the cerebrum may be taken, except the inferior portion of the occipital lobes which rest on the tentorium. At the base of the cranium the bony ridges are more prominent, but in the superior regions the depressions are more developed, and the intervening lines are softer and less projecting. On account of the frontal sinuses, and of the diploe, the external surface of the skull does not by any means exactly represent the internal, but is more smooth and even, and never accurately presents eminences and depressions inversely corresponding to those within; to some extent, however, and only to some, does the external surface of the bones indicate the projections on the surface of the brain; when a certain portion of the latter, or a certain group of convolutions, are very prominent, the skull in that region will be prominent also, and *vice versa*; but we very seldom find distinct external elevations corresponding to individual convolutions.

The cerebrum, on its inferior surface, also, is divided into the two hemispheres by the great median fissure at each extremity, and in the centre by a remarkable depression; each hemisphere inferiorly is very uneven, and divided into three lobes, the anterior or frontal, small, triangular, flat, or a little concave, rests on the roof of the orbit, presents a deep groove, which lodges the olfactory lobe and bulb, and is separated from the opposite one by the median fissure, the falx and crista galli. The *middle* or *temporal*, or *parietal lobe*, is prominent, convex, and deep, fills the middle fossa in the base of the cranium, and is separated from the anterior by a deep fissure (*fissura Silvii*);

Fig. 69.*

this proceeds from the anterior and lateral part of the median depression, in front of the anterior inferior extremity of the great transverse fissure it ascends obliquely upwards, and backwards, is a little convex forwards, and divides into two minor fissures, which end in adjoining sulci; its margins are held together by the arachnoid, above which is the lateral sub-arachnoid space which communicates with the median. On opening it we see the middle cerebral artery large and tortuous; the entire surface is much convoluted, and between the lesser divisions of the fissure is a remarkable group of convolutions, known by the name of the "island of Reil;" at the inner end of the fissure, there is a small portion of brain perforated with many small holes (*pas perforee externe*), through which tufts of vessels from the pia mater pass to supply the corpus striatum; on plucking off these and the membrane, a fine white line an inch long is seen, the external root of the olfactory lobe. The middle lobe is bounded internally, and separated from the median depression, by the transverse fissure.

The *posterior* or *occipital* lobe, slightly concave, rests on the tentorium, and is but indistinctly separated from the middle, externally by a slight depression corresponding to the angle of the petrous bone, and internally by a deep sulcus between the convolutions. Between the round or mammillary surfaces of the middle lobes of opposite sides, is the median depression on the base of the cerebrum, over or beneath which the arachnoid (here rather strong), is tensely drawn; above this is the great median sub-arachnoid space traversed by shreds and fibres of the pia mater, and areolar tissue entangling more or less fluid, which bathes the remarkable arterial inosculation (circle of Willis) seated here. A little dissection will expose the following parts in this region, from before backwards: most anteriorly, directly behind the median fissure, is the anterior extremity of the corpus callosum, very thin, and reflected backwards: it expands somewhat, and is attached mesially to the optic commissure and tuber cinereum, and laterally to each perforated plate in the Sylvian fissure; behind this is the optic commissure, or the union of

* The inferior surface, or base of the brain. 1. The anterior extremity of the great median fissure. 2. Its posterior extremity. 3. 3. Anterior lobe of each hemisphere. 4. 4. The middle lobe. 5. The fissure of Sylvius. 6. 6. The posterior lobes of the cerebrum partly concealed by. 7. 7. The lateral lobes of the cerebellum. 8. The pneumogastric lobule. 9. The olfactory lobes. 10. The commissure of the optic nerves. 11. The tuber cinereum and infundibulum projecting from it. 12. The copora mammillaria or pisiform tubercles of the fornix. 13. The locus perforatus medius. 14. The third nerve. 15. The crus cerebri. 16. The pons Varolii. 17. The crus cerebelli. 18. The fourth nerve. 19. The fifth or trifacial nerve. 20. The sixth pair of nerves. 21. The portio dura, and 22. The portio mollis of the seventh nerve. 23. The corpora pyramidalia of the medulla oblongata. 24. The corpus olivare. 25. The corpus restiforme. 26. The glosso-pharyngeal division of the eighth nerve. 27. The pneumogastric division, or par vagum. 28. The spinal accessory nerve. 29. The roots of the ninth, or lingual nerve. 30. Superior portion of the medulla spinalis.

two flat white tracts which may be traced backwards as far as the optic thalami, in a semicircular course round each crus cerebri, and bounding this median depression on each side; from the commissure anteriorly diverge the optic nerves to their respective orbits; behind this, and connected to it, is a soft, gray substance, the *tuber cinereum*, from the centre of which a thin, conical, tubular *cul de sac* of a reddish color descends (the *infundibulum*), behind and rather beneath the commissure of the optic nerves, and terminates on the surface of the pituitary body, surrounded by arachnoid and pia mater; is not pervious inferiorly, but communicates above with the third ventricle. The *pituitary* body is placed in the sella Turcica, between the dura mater and arachnoid membrane; transversely oval, composed anteriorly of a yellowish substance, which is notched before, and convex behind like a kidney, and posteriorly of a whitish, semi-fluid, or pulpy substance; its connection to the brain is so slight as to give way in raising the latter from the base of the skull, and it is difficult to dislocate it out of the cella Turcica, as the dura mater covers it, leaving only a circular deficiency for the attachment of the infundibulum. Behind the infundibulum and tuber cinereum, and connected to the latter, are two small white bodies termed the *corpora mammillaria*, or *albicantia* or *pisiformia;* these are about the size of small peas, they are gray internally, white externally; the anterior pillars of the fornix terminate in these; though separate below, they are joined above by the tuber cinereum; they assist in closing the third ventricles, and are probably of a ganglionic character. Behind the corpora albicantia, is a small triangular depression, closed above by a thin plate which forms the posterior part of the floor of the third ventricle; this is the *middle perforated plate of the brain*, also called the *intercrural lamina*, as it joins the crus cerebri on each side; it is also named "pons Tarini;" tufts of small arteries pass through it, to supply the crura cerebri and optic thalami; the third pair of nerves is partly connected to it; immediately behind this is the upper and anterior border of the pons Varolii, with its median groove lodging the basilar artery, and on either side of it are the *crura cerebri*, or the peduncles of the cerebral hemispheres; these appear as two short, round, and thick fibrous cords, attached below to the pons Varolii, ascend and diverge, and are continued upwards into the optic thalami and corpora striata in each hemisphere; the third pair of nerves is connected to them internally, and the optic tracts wind round them externally. Below the pons is the medulla oblongata, which we shall not further notice at present; and above and behind the pons are the tubercula quadrigemina, above which is the posterior, thick, doubled-like end of the corpus callosum; and between these is the median, or transverse portion of the great cerebral fissure, which thence extends on each side downwards and forwards, as far as the inner end of the Sylvian fissure, internal to the middle lobe, and external to the crus cerebri and optic tract; through this descending portion, the choroid plexus enters the lateral ventricle, and in the middle or transverse portion are situated the pineal body, the venæ Galeni, the velum, and the arachnoid canal; the fourth pair of nerves is nearly parallel to this fissure; behind the middle or transverse portion of it the tentorium is seen, and above this is the continuation of the median fissure between the occipital lobe of each cerebral hemisphere.

Cut off the upper part of one hemisphere nearly on a level with the corpus callosum, the appearance presented is termed the *centrum minus ovale*, that is, a mass of white fibrous substance surrounded by an irregularly undulating line of gray; the small cavity or fissure may also be observed between the corpus callosum and the lower and internal margin of each hemisphere: next slice off both hemispheres on a level with the corpus callosum, and the *centrum magnum ovale* is presented, that is, a line of gray substance surrounding the central mass of white; in this section the continuous marginal line of gray

neurine is well seen, with its convoluted and tortuous windings and map-like indentations, and this view explains how the superficies of this lamina is thereby extended, so as to present numerous points of contact to the white fibres radiating from the centre; to these convolutions and involutions we shall again allude, when we have concluded the dissection of the organ. The white centre in many parts appears distinctly fibrous, and dotted with red spots, divided vessels, which vary in number and in size in different subjects; in a very fresh brain, when this section has been made, the white substance will often by its elasticity force the blood to exude for some little time in small drops.

The *corpus callosum*, or *great* or *superior cerebral commissure*, is now seen in the median line of the cerebrum, nearer the frontal than the occipital bone, between three or four inches long, convex, white, marked by two or three raised longitudinal lines closely and nearly parallel to each other (*the raphe*), from these several transverse lines pass to either side; its posterior end, thick, broad, round, and a little concave, is bent downward above the transverse fissure, and is continuous with the fornix and the hippocampi; its anterior end is also round, is bent downwards and backwards, and continued on each side into the anterior lobes; in the middle it joins the tuber cinereum, and the optic commissure: the corpus callosum connects the white fibrous substance of the hemispheres, and is therefore properly called the great commissure of the cerebrum; some portion of it also curves downwards external to the lateral ventricles, and joins the optic thalami and corpora striata, between which bodies of opposite sides it may also serve as a commissure; it bears a ratio in size to the hemispheres, and is wanting in fish and reptiles, and is only rudimental in birds; the longitudinal fibres of the raphe are probably commissural between the transverse; the fibrous structure, both in the transverse and longitudinal direction, is often as distinct as that in any nerve; it covers like an arch the lateral ventricles, the septum lucidum, and the fornix, and curves downwards and forwards in front of, and then beneath these parts; the under surface of its posterior extremity is identified with the fornix, and assists in forming with the latter that appearance called *lyra* or *psalterium;* on either side of this it is continuous with the hippocampi or the fibres of the adjacent convolutions in the posterior and middle lobes. Divide it at a little distance from either side of the raphe; and the lateral ventricles will be opened; press the middle portion of the corpus callosum to one side, and the septum lucidum may be seen descending in the median line from it to the upper surface of the fornix.

The *septum lucidum* separates the two latèral ventricles, triangular, the apex behind, the base before, the upper edge connected to the corpus callosum, the lower to the fornix posteriorly, and anteriorly to the inferior curved portion of the corpus callosum; a vein is often seen on either side of it. It consists of four laminæ on each side: the first is the lining membrane of the ventricle; the second is a thin gray layer; the third a compact, white, fibrous one; and lastly a most delicate membrane which lines the small cavity which exists in it, termed the *fifth ventricle.* The cavity is naturally closed, but when the corpus callosum is divided transversely, and its anterior portion raised forwards, the laminæ of the septum separate, and this space usually appears; it is larger in the child, but is very irregular in size, and even in existence, in different subjects; in some it is very distinct, and contains a fluid; it may be regarded as a portion of the third ventricle shut off by the fornix: Tiedeman states, that in the early period of uterine life it communicates with that cavity. The septum lucidum appears to be formed by a white lamina descending from each side of the inferior surface of the raphe of the corpus callosum to the fornix, some gray matter being superadded; in function it is probably commissural. Divide transversely the septum luci-

dum and corpus callosum, raise forwards the anterior portion of the latter, and backwards its posterior part; it will now be seen that the corpus callosum is united to the fornix posteriorly, but is nearly an inch above it anteriorly; the septum lucidum is generally so soft, that in this stage of the dissection it will have nearly broke down into the surrounding fluid.

The *lateral ventricles* extend from the middle of the brain into the anterior and posterior lobes, also into the inferior part of the middle lobe; hence they are named *tricorne.* The *anterior cornua* diverge a little, as each passes forwards and outwards; the middle portion, or *the body,* passes horizontally backwards; both this and the former are separated from the opposite by the septum lucidum; near the posterior part of the corpus callosum the posterior and inferior cornua pass off in different directions. The *posterior* proceeds into the posterior lobe, at first outwards, and then curves inwards, the concavity towards the median line. The *inferior cornu* descends obliquely forwards and outwards into the middle lobe, and is then also curved a little inwards; it terminates behind the fissure of Sylvius, and beneath the anterior cornu. The anterior is bounded superiorly and laterally by the corpus callosum, and inferiorly by the large extremity of the corpus striatum; the middle, or body of each, is bounded superiorly and externally by the corpus callosum; internally by the septum lucidum, and inferiorly by the posterior extremity of the corpus striatum, the lamina cornea, the tænia semicircularis, the optic thalamus, the choroid plexus, and the fornix. The posterior cornu, or digital cavity, is bounded superiorly and laterally by white substance, and inferiorly by the hippocampus minor. The inferior cornu is bounded superiorly by the optic thalamus and corpus striatum, externally by white substance; internally it is deficient of cerebral substance, and presents the transverse or great cerebral fissure, which is closed by the arachnoid membrane only; inferiorly by the hippocampus major and corpus fimbriatum, or tænia hippocampi, over which the choroid plexus is folded.

These several bodies, observed in the different regions of these cavities, must next be examined individually; and, first, the *corpora striata.* These pyriform bodies are anterior and external to the thalami, their larger ends are directed forwards and inwards, their posterior small and pointed extremities backwards and outwards, and then curve downwards and forwards in the inferior cornua; smooth and unattached superiorly and internally, covered only by the soft and delicate lining membrane, with two or three considerable veins; on all other sides they are continuous with the white substance; vascular, soft, and cineritious on their surface, they will be found, when cut into, to consist of gray substance, intermingled with the white striæ or fasciculi; the latter may be traced from the anterior or motor portion of the crura cerebri through these bodies to the upper and anterior part of the cerebrum, hence they are named the *anterior* or *superior ganglions* of the cerebrum, and are said to bear a ratio in size to that of the anterior and middle lobes; the corpora striata are also regarded by some as the centres of volition, as the fibres which traverse them are the motor tracts of the spinal cord. To expose these white striæ, an incision should be made obliquely through either, from the crus cerebri below, upwards and outwards, parallel to the fibres, which, as they ascend, diverge and radiate in every direction; if the section be horizontal, the surface will only present white spots, intermingled with gray substance; the fibres in passing through it subdivide very minutely, the interstices being filled with gray neurine; of the fibres, which can be traced into it from the crus cerebri, some only can be traced through it into the hemisphere; others appear to terminate in it, while many other fasciculi, not continuous with the preceding, emerge from it and pass, some upwards into the hemispheres and into the great commissure, and others inwards into the thalamus; the fasciculus, which forms the anterior commissure, passes through the anterior part

of each of these bodies, and thus connects them to each other. The corpora striata, therefore, are connected to several parts of the brain; first, through the crura cerebri to the pons, medulla oblongata, and spinal cord; second, to the optic thalami; third, to the hemispheres; and lastly, to each other, by the anterior commissure and by the corpus callosum.

The *lamina cornea* is a narrow, semi-transparent band, of a horny appearance, but very variable; it occupies the angle between the corpus striatum and thalamus, and covers a vein which passes from the former to the choroid plexus. Many consider it as only a thickening of the lining membrane; it often, however, presents a fibrous appearance, and may be a mere separation by the vein of a portion of the following:

Tænia semicircularis is a narrow band, white and fibrous, placed in the groove between the optic thalamus and corpus striatum. It *arises* narrow from a tubercle on the back part of the optic thalamus (corpus geniculatum externum) and from the fibres of the middle lobe at the upper part of the inferior cornu; passes forwards and inwards, becomes broader, and joins the descending pillar of the fornix: in function it is probably commissural, like the fornix.

The *choroid plexus* is a fold of thin and very red vascular membrane, derived from the pia mater, broad below, narrow above; it enters the inferior cornu by the great cerebral fissure, between the optic thalamus and the tænia hippocampi; loose and floating it ascends obliquely backwards over the hippocampus major, then curves forwards, covering the thalamus, and overlapped by the fornix, beneath which it is connected to the velum interpositum; it ends by uniting with its fellow in the foramen commune anterius, behind and beneath the anterior pillars of the fornix. Each choroid plexus is covered by the arachnoid membrane; they receive a number of veins from the parietes of the ventricles, particularly from the corpora striata; these veins join the venæ Galeni, which will be noticed presently. Very frequently small vesicles, hydatids, and even small, hard tumors, may be found in these membranes; also sandy or calcareous matter, such as is frequently seen in the pineal body; they always present a number of small vascular tufts or villi, covered by a fine epithelium, on which the microscopical anatomists affirm that cilia exist, and that these have been seen in motion in the fœtus. The surface of each plexus is free, also the outer margin, but the inner is attached above to the velum, and below to the pia mater, between the margins of the fissure; to the latter the lining membrane of the ventricle also adheres, and closes the cavity so as to prevent the escape of fluid into the sub-arachnoid space. If any such escape ever take place, as some have supposed, it can only be by exosmose.

The *fornix* is a white, fibrous, triangular arch or vault, convex above, situated horizontally beneath the corpus callosum and septum lucidum, continuous with the former posteriorly, attached to the latter anteriorly and in the median line; it lies on the velum interpositum and choroid plexuses, and over the third ventricle; the base, posteriorly, *arises* by two long flat bands (the *posterior pillars* or *crura*) one from either side, by three roots, from the hippocampus minor and major, and from the tænia hippocampi; these crura pass forwards and inwards, and unite (the *body of the fornix*); this bends forwards and downwards, over the foramen commune anterius, and divides into two short, round, white cords (the *anterior pillars of the fornix*); these descend behind the anterior commissure, and end in the corpora mammillaria; the gray substance of the tuber cinereum is also connected to and continued upwards upon them for some distance. The superior surface, on each side of the septum lucidum, and its margins, are smooth and free, and form part of the floor of the bodies of the lateral ventricles, and rest on the velum interpositum; the edges are very thin, and sometimes overlapped by the choroid plexuses. The inferior

surface of the fornix, together with the intervening portion of the corpus callosum, which rests on the velum, is marked posteriorly by several fine oblique lines (*lyra*, or *corpus psalloides*). The fornix maintains several and very distant communications, commencing in the inferior or middle and posterior cerebral lobes, its two crura soon become connected to the corpus callosum and septum lucidum, and through these to each other, and, as its anterior crura descend, they are connected to the forepart of the optic thalami, to the pedunculi of the pineal body, to the tæniæ semicirculares, to the anterior commissure, tuber cinereum, corpora albicantia, optic commissure, and anterior extremity of the corpus callosum; its structure is evidently fibrous, and the fibres pass from behind forwards; it is considered as an important and extended commissure, connecting the several parts enumerated, not only on each, but also on opposite sides; hence it may be named the *great inferior commissure of the cerebrum*, in distinction to the corpus callosum: the latter, however, is chiefly a transverse commissure, while the fornix is a longitudinal or antero-posterior bond of union. Though described as a single organ, it is really double or symmetrical, and perfectly divisible throughout, except where the lyra unites the opposite sides. Although the septum lucidum is a partition between the lateral ventricles, yet these cavities communicate together, as also with the third or middle ventricle, through an opening termed *foramen commune anterius;* this is situated in the median line at the anterior part of the body of each ventricle; it is bounded superiorly and anteriorly by the fornix, posteriorly by the optic thalami; laterally it leads from one lateral ventricle to the other, and inferiorly it opens into the third. The apex of each choroid plexus turns into this opening to join the velum. The optic thalami cannot be fully examined at present.

In the posterior cornu, or digital cavity of each ventricle, is a small eminence, the *hippocampus minor,* large anteriorly, small and pointed behind, white on the surface, gray within; it corresponds to a sulcus or longitudinal involution on the inferior surface of the posterior lobe. In the inferior cornu we see the *hippocampus major,* or cornu Ammonis, a large, white substance, convex externally, concave internally, smooth and white on the surface, gray within, extending all along the floor of the cavity, and ending in a tuberculated expansion, the *pes hippocampi.* This well-marked eminence is but the internal surface of the lower and posterior extremity of the great internal or "ourlet" convolution, which forms the inner border of each hemisphere, above the commissura magna, and extends downwards and backwards, both before and behind, to the base of the brain, as far as the fissure of Sylvius. The posterior inflection of this convolution, on the lower surface of the middle lobe, appears bent inwards upon itself like a horn, external to the cerebral fissure; a deep depression on the lower surface corresponds to this curved eminence in the lower cornu of the ventricle; along its internal or concave edge, and connected to it, is a narrow white band, the *tænia hippocampi,* or *corpus fimbriatum,* the concave edge of which is loose. This latter substance is directly continuous with the posterior pillar of the fornix; beneath the tænia hippocampi a narrow, cineritious line may be observed shorter than the tænia, its edge is serrated; this is the *corpus denticulatum,* or fascia dentata. Divide the fornix about its centre, draw forwards its anterior portion, and the foramen commune anterius will be seen; throw the posterior portion, or the lyra, backwards, and the *choroid membrane,* or the *velum interpositum,* will be exposed; this is of a triangular form, beneath the fornix, and above the arachnoid canal, the optic thalami, the pineal gland, and the third ventricle; the choroid plexuses are united to it laterally and in front; the *venæ Galeni* extend along its median line; these veins receive the blood from each plexus, and from the different eminences in the ventricles; they pass backwards, and end in the straight sinus; they sometimes first unite into one trunk. The

velum is formed of the pia mater, continued from the surface of the brain through the great transverse fissure, which is beneath the corpus callosum and the fornix, and above the tubercula quadrigemina and the pineal gland; it is also covered by the arachnoid membrane, which is of extreme delicacy; its apex is in the foramen commune anterius, arched, and a little bifid, and is joined by the two choroid plexuses; from its upper surfaces fine vessels pass into the fornix. Raise it carefully from before backwards, dividing as you proceed the many small vessels which pass to it from the optic thalami; these bodies will be now exposed, and posterior to these the pineal gland, and the superior surface of the tubercula quadrigemina; the anterior extremity of the arachnoid canal also is seen; this small orifice is beneath the veins of Galen and above the gland; it is in general surrounded by small granulations, and is often closed. If the velum be not raised gently and carefully, the pineal body will be disturbed, and its other connections broken, as it is intimately attached to the velum by a fine membrane, which descends from it on either side of the venæ Galeni, to invest this organ in a sort of capsule. Along the inferior surface of the velum, in the median line, are two small fringed or granular lines, connected by vessels to the optic thalami; these are analogous to the lateral choroid plexuses, and are named the *choroid plexuses of the third ventricle;* remove the velum.

The *pineal body* is situated above the tubercula quadrigemina, behind and between the thalami, about the size of a pea, cineritious, heart-shaped, the base, looking forwards and upwards, contains in general some sandy particles (the *acervulus*); the posterior inferior part or apex is soft and pulpy (the *conarium*), and surrounded by and adherent to a very vascular membrane derived from the velum; it rests upon the nates and posterior commissure, but unconnected to the brain in every situation, except anteriorly, whence a small transverse medullary band proceeds, which has a slight connection to the posterior commissure, and then divides into two long delicate processes (*pedunculi*, or *habenæ*); these pass forwards adhering to the inner margins of the optic thalami, and join the descending pillars of the fornix and the tæniæ semicirculares at the foramen commune anterius. The pineal body exists in all mammalia, but is absent in birds, fish, and reptiles, except in some of the chelonia. Various theories have been entertained as to its function. Descartes considered it to be the seat of the soul, and the great source of nervous power: Majendie that it stops the aqueduct of Sylvius, and thus prevents the passage of fluid from the third into the fourth ventricle. It is most reasonable to suppose it is connected with the system of commissural fibres, which extend from the quadrigeminal mass and posterior commissure, along the optic thalami, to the descending crura of the fornix, and through these to the corpora albicantia and optic commissure. The earthy matter it contains is usually but not constantly confined to the base, or, as it is termed, acervulus; it is composed principally of phosphate and carbonate of lime in minute crystals, similar to what is less frequently met with in the choroid plexuses.

The *optic thalami* are two large, firm, gangliform bodies, about an inch and a half long, and three-quarters of an inch in depth and breadth, placed obliquely, diverging behind, converging before, behind and between the corpora striata, to which they are intimately connected, though distinguished from them superficially by the groove which contains the tænia semicircularis and lamina cornea; the upper surface of each is smooth and free, of a grayish tint, but much whiter than that of the corpus striatum, and appears on the floor of the lateral ventricles, overlapped by the velum and fornix; externally, it is continuous, partly with the fibres of the hemisphere, and partly with the corpus striatum, but behind this it is free and smooth also, and enters into the surface of the inferior cornu of the ventricle; posteriorly it is connected to the quadrigeminal bodies, and to the processus a cerebello ad testes; in-

feriorly it rests upon the crus cerebri; internally it is gray, smooth, and free, except where it touches its fellow in the soft commissure, and forms the side of the third ventricle; the white band or peduncle of the pineal body marks its superior and internal border, arching over the soft commissure; its anterior extremity bounds the foramen commune anterius behind; beneath its posterior free end, and above the crus cerebri, is a roundish grayish eminence, perforated with small foramina, named *corpus geniculatum internum;* this is connected to the natis by a fibrous band; a little lower down and more anterior is another smaller and paler eminence, named *geniculatum externum*, a fibrous band connects this to the testis; the optic nerves are connected to these two eminences, and to the tubercula quadrigemina, and but slightly to the thalamus; anteriorly and inferiorly the optic thalamus is connected to the descending crus of the fornix, corpus albicans and tuber cinereum; when cut into, it presents a reddish gray color; numerous small, white fibres are seen passing through it, not in such large and distinctly radiating fasciculi as in the corpus striatum, but more reticulated or plexiform, as in the ganglions, the interstices being filled with gray neurine; the superficial fibres appear to radiate into the hemisphere; the fibres in each are continued from the olivary or the sentient tract, and from the processus a cerebello ad testem, also from the upper and posterior part of the crus cerebri, with which it is directly continuous, appearing as a ganglion swelling out from it, like the corpus striatum in front, hence it is named the *great posterior cerebral ganglion*, and has been observed to bear a ratio in size to the posterior cerebral lobes, but not to the optic nerves, which are connected to the corpora geniculata; a section of these latter tubercles presents a distinct line between them and the thalamus; from these the tractus opticus proceeds on each side, forwards, downwards, and inwards, adhering to the thalamus, and to the crus cerebri. The thalami are regarded by some as the centres of sensation, as the corpora striata are of motion.

The *commissura mollis* is a broad, soft, and cineritious union between the internal surfaces of the thalami anterior to the centre; before this commissure is the *foramen commune anterius*, and behind it is the *foramen commune posterius;* this last-named opening is between the peduncles of the pineal gland, but is so closed by the velum and the fornix, that no communication can occur through it between the third and the two lateral ventricles, as through the anterior.

The *commissura mollis* is of a very variable extent and consistence, is composed of gray neurine, and thus differs from the general system of commissures, which are white; but is similar to the intercrural or perforated lamina between the crura cerebri, which is also probably commissural to those bodies. When the soft commissure is broken we see the following space:

The *third ventricle* is a narrow cavity placed in the median line, bounded on each side by the optic thalami, above the velum and the fornix, below by the locus perforatus and tuber cinereum, before by the descending pillars of the fornix and the anterior commissure, behind by the posterior commissure and pineal gland, by its pedunculi and by the tubercula quadrigemina; its whole surface is coated over with gray neurine, which forms one continuous connection between its parietes. The foramen commune anterius opens into the upper and anterior part of this cavity; the infundibulum leads from the lower, anterior, and deepest part, downwards and forwards, between the pillars of the fornix and below the anterior commissure, to the pituitary body; this canal is large above, but it is generally impervious below. From the posterior part of the third ventricle, which is much contracted in size, a small canal leads backwards and downwards, above and behind the pons Varolii, and below the tubercula quadrigemina, this is the *aqueduct of Sylvius*, or the *iter ad quartum ventriculum.* The third ventricle is but the median line of

separation between the roots of the two hemispheres; this line may be considered as extending from the upper margin of the pons Varolii, and between the crura cerebri, to the convex surface of the hemispheres, and dividing the cerebrum into two symmetrical portions. It is crossed by several commissures: viz., the corpus callosum, fornix, commissura mollis, anterior and posterior commissures, middle perforated plate or intercrural lamina, and tuber cinereum; the iter ad quartum is only the continuation of the same line covered over by the tubercula quadrigemina, and upper part of the cerebellum, and accordingly during the early stages of development it is open, until the lateral boundaries meet over it in the middle line; the fifth ventricle between the laminæ of the septum lucidum, may, in like manner, be considered as part of the same median division. The two lateral ventricles, and the third or middle, now that the corpus callosum and fornix are removed, and the commissura mollis is broken, obviously present one surface covered by the vascular choroid membrane, continuous with, or an extension of the external cerebral surface; and the eminences which we have noticed upon it, namely, the corpora striata, the thalami and hippocampi, may be regarded as masses of gray neurine, or internal convolutions to which the white fibres are connected, as the latter are to the superficial convolutions of the hemispheres, which may be considered as one great hemispherical ganglion on each side, or as a series of ganglions connected to each other.

The *anterior commissure* is a distinct round cord, extending from one hemisphere to the other, immediately before the anterior pillars of the fornix, bent like an arch, convex anteriorly, unattached and cylindrical in its central portion, but on each side it is flattened and imbedded in the corpus striatum, through which it descends obliquely backwards and outwards, and then terminates in rays near the fissure of Sylvius, and the inferior cornu of the lateral ventricle: it is inclosed in a delicate sheath of pia mater, like a nerve; it is a true commissure between the corpora striata, and the convolutions of the middle lobes of each side.

The *posterior commissure* is shorter and smaller than the anterior, but white, round, and fibrous like it; it extends transversely behind the third ventricle, above the aqueduct of Sylvius, below the pedunculi of the pineal gland to which it is connected, and anterior to the tubercula quadrigemina; its extremities are connected to the optic thalami.

The *crura cerebri* are the last parts to notice in the dissection of the cerebrum from above downwards, and may be seen either by dividing the floor of the third ventricle and divaricating the thalami, or still better, by a little dissection on the base of the brain above the pons. They are two thick fibrous cords descending from the optic thalami and striata, about half an inch long, and converging they enter the pons, in which they are continuous with the ascending columns of the medulla oblongata; near the pons they are in contact and nearly cylindrical: as they ascend, they diverge and pass a little forwards, become enlarged and flattened, and enter the two great cerebral ganglions on each side; the optic tracts surround them externally and in front; their white fasciculi are very distinct, and bloodvessels enter foramina between these; white bands from the tubercula quadrigemina, or from some part of themselves, often cross their surface at right angles; as they diverge from the pons, they are united by the intercrural lamina, or middle perforated plate; connected to them superiorly and posteriorly are the tubercula quadrigemina; they form the lower wall of the iter a tertio ad quartum ventriculum. An oblique groove on the inner and anterior aspect of each, points out a division into two portions: one is small, anterior, and inferior to the other, and can be traced upwards into the corpus striatum, and is found to be continuous inferiorly with the anterior pyramidal tracts in the pons; the other, or larger portion, is the continuation of the olivary tracts, and can be followed

into the optic thalamus. If a section of the crus be made, the surface will present, near its centre, a semilunar mass of gray neurine of a very dark shade, and, therefore, named "locus niger;" in it the neurine vesicles are found by the microscope to be of a caudate form, and intermingled with many pigmentary particles; this appearance is confined to the crus, but does not end abruptly; beneath this mass the inferior small fasciculus of the crus is placed, and above it is the superior or larger one. The crura cerebri are said to bear a ratio in size to that of each hemisphere; the third pair of nerves is connected to their inner surface. The next division of the encephalon is the *mesocephale*, the limits of which cannot be accurately defined, as it is continuous with the crura cerebri above, with the crura cerebelli on either side, with the medulla oblongata below, and above and behind with the cerebellum itself. Many, without any impropriety, consider it and the medulla oblongata as one mass. We shall speak of them, however, distinctly, and consider the mesocephale as consisting of the tubercula quadrigemina, and of the cerebral protuberance or pons Varolii. We have already mentioned the pineal body as a portion of the cerebrum, though some connect it with the mesocephale.

Tubercula quadrigemina.—As we are pursuing the dissection from above these first are met with, forming the upper and anterior part of this division; they are situated below and behind the posterior commissure and the pineal gland; they are four round, gangliform tubercles, all connected by their bases into one mass on an oblique plane, but separated from each other superficially by two grooves, a transverse and a vertical or median; the two superior and anterior are the larger, and called the *nates*, the two inferior and posterior are smaller, and named the *testes*. They all lie above and behind the crura cerebri and the olivary tracts, which ascend from the medulla oblongata, through the pons and crura, to the optic thalami; they are also above the aqueduct of Sylvius, which separates them from the pons Varolii. The nates are connected to the optic thalami; the testes to the cerebellum, by two thin, white plates, which descend obliquely backwards and outwards, and end in the substance of the cerebellum; these are the *processus a cerebello ad testes;* they diverge towards the cerebellum, and are continuous externally and inferiorly with a thick, round, white cord, the crus cerebelli. Between the two processus a cerebello there is a thin lamina extended, named the *valve of Vieussens*, or of the *fourth ventricle;* triangular, the apex is between the testes, the base is attached to the cerebellum, and the sides to the two processes just described; this valve forms the roof of the fourth ventricle, it is overlapped by the superior vermiform process, and is very delicate, being composed of a white lamina, with a thin stratum of gray neurine, which is marked with transverse indentations and eminences like the laminæ of the cerebellum, of which it is evidently a continuation; and, therefore, this valve or process is rather a portion of this organ than of the mesocephale. The fourth pair of nerves are seen to arise from it, and from the lateral processes, by one or two fine filaments. If a probe be passed along the aqueduct of Sylvius, and the valve of Vieussens divided, the cavity of the *fourth ventricle* will be exposed. The four tubercles are covered by a very vascular membrane from the velum, from which numerous vessels are seen to pass into their substance; they are white on the surface, but the nates are of a grayer tint than the testes; when divided, the section resembles that of the thalami, and presents white fibres intermingled with gray neurine, like other ganglionic bodies. In fish, reptiles, and birds, there are only two tubercles corresponding to these four, and are decidedly the optic lobes; in birds they are very large; in mammalia we find the four eminences; the nates are large in the herbivoræ, and the testes in the carnivoræ, and are all better developed than in man. The next and principal portion of the mesocephale is the following:

The *pons Varolii*, or *great commissure of the cerrebellum*, or cerebral pro-

tuberance, can be better examined when the brain is removed from the subject, and the base placed uppermost. It is somewhat square, is placed obliquely on the cuneiform process, between the cerebrum and cerebellum; the fourth ventricle, the aqueduct of Sylvius, and the tubercula quadrigemina, are on its superior and posterior surface; its inferior and anterior surface rests on the bone, and is grooved longitudinally by the basilar artery, numerous branches from which enter its structure between the transverse fasciculi. Its superior extremity receives the crura cerebri, which it surrounds like a ring, hence it is sometimes called the annular protuberance; the crura cerebelli are attached to its sides, and the medulla oblongata to its lower extremity, from which it is distinguished by a deep groove. The pons is of a more firm structure than any part of the brain; its surface is white and fibrous; the superficial layer of fibres on its inferior surface runs transversely from the inferior surface of one crus cerebelli to the other, hence this lamina has been very properly named the commissure of the cerebellum. These fasciculi are large and coarse, with intervals between them for the entrance of vessels; they are more separate towards the centre than at either side, where they are compressed; hence the pons appear deeper in the former than in the latter situations. In the median groove the fibres are condensed, and some are found to pass inwards and interlace with those in the anterior; these superficial fasciculi can be raised off in layers, and gray neurine is intermingled with the deeper fibres; they constitute about one-third of the thickness of the organ, and are always found to bear a ratio in size to that of the hemispheres of the cerebellum, as may be proved by inspecting it in birds, reptiles, and fish, where these portions are absent, or only rudimental, and these transverse fasciculi are nearly absent also. Beneath these transverse fibres a quantity of cineritious substance exists, through which white fibres may be seen to ascend obliquely outwards, in the direction of the crura cerebri; these are the tracts from the medulla oblongata and spinal cord, named the pyramidal columns; they ascend on either side of the median depression, and contribute to the lateral convexities on the surface; these fibres are separated by and intermingled with gray neurine, and interlace at right angles with the white, transverse, commissural fasciculi; they enter each crus cerebri, hence the pons Varolii is described by some authors as a portion of the medulla oblongata; it is, however, so connected with it, as well as with the cerebrum and cerebellum, that it may be considered as equally common to all, and is truly a compound body, its inferior or anterior portion being commissural to the cerebellum, and the remainder a ganglionic mass receiving and transmitting the ascending nervous columns to the crura cerebri.

SECTION III.

DISSECTION OF THE CEREBELLUM, OR LESSER BRAIN.

Remove the posterior lobes of the cerebrum, divide the tentorium, and the cerebellum will be exposed. This organ, like the cerebrum, is larger in man than in any other animal, and is believed by many to be larger in proportion in the male than in the female. In size and weight it bears a ratio to the cerebrum of about one to eight, the average weight of the latter being two pounds and a half, and that of the cerebellum four ounces and a half. It is securely lodged in the inferior occipital fossæ, and is covered by the tense tentorium, which supports above it the weight of the posterior cerebral lobes; it is above and behind the medulla oblongata and the mesocephale. In form it contrasts with that of the cerebrum, being oval in the transverse direction,

and raised in the centre, where, contrary to the cerebrum, its right and left hemispheres are united. It is composed, like the cerebrum, of white substance internally, and of gray upon its surface, but the latter is marked by a great number of narrow parallel lines, which run semicircularly, convex posteriorly; these are fissures to the bottom of which the pia mater descends, the arachnoid membrane passing over them. They are in some measure analogous to the sculci on the cerebrum, that is, they are involutions of the gray substance, the superficial extent of which is thus considerably augmented; the same appearance is also observable inferiorly, but the lines there are not so numerous or regular as above; some lines pass in very deep into the cerebellum, and divide it into lobes, and are called *primary;* others are only superficial, and divide it into lobules, and are called *secondary.* The deep lines or sulci, unlike those on the cerebrum, are closed below by white substance, and, therefore, the gray neurine does not form one continuous surface over the cerebellum as it does over the cerebrum. The cerebellum presents for our observation two surfaces, superior and inferior, a convex border or circumference, which separates these from each other, and a median notch behind and before. The *posterior notch* is very deep; it receives the falx cerebelli and the inferior occipital crest, and extends mesially along the under surface as far as the back of the medulla oblongata: this extension is very deep, and is called the *valley, or purse-like fissure.* The *anterior notch* is broad, overlaps the fourth ventricle, and embraces the cerebral protuberance and tubercula quadrigemina. These two median notches mark a division of the cerebellum into right and left hemispheres; the circumference of each of these is deeply indented by the *horizontal fissure;* this penetrates to a great depth, is lined by pia mater, and is bounded below by white substance; this fissure extends on each side as far forwards as the side of the pons, parallel to each petrous bone; posteriorly it leads into the valley; it forms the bounding line between the upper and lower surfaces. The white neurine of its floor will be seen hereafter to be continued into the fibrous band called crus cerebelli.

The *upper surface of the cerebellum* presents on either side an inclined plane, marked by concentric lines and laminæ, and in the middle line a ridge or process, very prominent in front, where it overlaps the valve of Vieussens and the quadrigeminal mass; this is named the superior vermiform process, or the middle superior lobe. The *inferior surface* of the cerebellum is very convex on each side, but deeply depressed by the valley in the median line; the sides of this space are held together by the arachnoid membrane tensely extended from one to the other; when this is divided, and the space expanded, it has somewhat a lozenge form, and is occupied by a portion of cerebellum, which is laminated, and shaped into different small masses by fissures and plaits; this is the inferior vermiform process, but it may be seen that this is continuous with the lower part of the superior vermiform process.

These two processes, which have received these distinct names, improperly but now sanctioned by long practice, are really but one, and ought to be named the median lobe, or the primitive lobe of the cerebellum. Comparative anatomy justifies this remark: in fish and reptiles this median lobe alone exists; in birds, the lateral portions first appear as small offsets; but in mammalia these enlarge in a greater ratio than the central or fundamental portion. The cerebellum, therefore, is divisible, first, into two lateral hemispheres, and the middle or primitive lobe; this division is marked by the anterior and posterior notches, by the prominence of the median lobe above, and by the valley or great median longitudinal fissure below; and, secondly, into a superior and inferior surface, the distinction between which is evident from their different aspects and from the deep horizontal fissure in the circumference, which on each side connects the anterior and posterior notch.

The *right and left hemispheres* may be considered symmetrical, though a difference in size has been more frequently remarked than between the cerebral hemispheres. Each presents on its superior surface the lines or sulci, and laminæ, already noticed, forming large curves, concave forwards, parallel, and concentric; most of those of one side are continuous with those of the other, through the superior vermiform process, in which, however, their direction is altered, being convex forwards. When the pia mater is detached, the sulci can be opened, and the distinction between the primary and secondary lines becomes obvious; one deep or primary sulcus marks two lobes on the upper surface of each hemisphere, one posterior, the other anterior.

The *superior posterior lobe* is semilunar, extends to the convex border, is separated by the horizontal groove from the inferior posterior lobe, and by the posterior median notch from its fellow, to which, however, it is connected by transverse lines, which cross and bound the floor of that fissure.

The *superior anterior lobe* is an irregular square, it extends as far forwards as the anterior notch, is distinguished from its fellow and connected to it by the several transverse laminæ of the superior vermiform process. Both these superior lobes consist of numerous lobules, and these again of smaller laminæ or leaflets, distinguished by the secondary lines, and placed in close apposition, like the leaves of a book. Each lobule and lamella consists of a delicate white centre, which, like a root or stalk, adheres to the white central nucleus of the hemisphere, and is covered on its convex edge and its two lateral surfaces by gray or vesicular neurine and by pia mater. When the section of the cerebellum shall have been made, as will be directed presently, this structure of the lobes, lobules, and laminæ, or leaflets, will be more distinctly displayed; but even in the present stage of the dissection it may be partially exposed by opening the deep sulcus, and scraping off some of the gray coating from the lamellæ between the secondary fissures.

The *inferior surface* of each hemisphere is very convex, and also marked by concentric sulci, primary and secondary; the primary lines mark out five lobes on each, viz., the posterior or semilunar, the middle or gracilis, the anterior or digastric, the anterior or internal, or the amygdaloid or tonsillitic, and the anterior inferior, or the floculus or pneumogastric lobe or tuft.

The *inferior posterior lobe* is semilunar, extends to the convex border below the horizontal groove, and is separated from its fellow by the posterior inferior median fissure, though connected to it by the transverse laminæ on its floor.

The *gracilis* or *middle lobe* is placed transversely between the last and the following.

The *digastric lobe* is a large mass, extends to the anterior and external border of the hemisphere, narrow internally, wide and bifid externally; the inner extremities both of this and of the thin lobe are connected to those of the opposite side across the valley by transverse laminæ, which project into a process called the pyramid, from the inferior median lobe or vermiform process.

The *amygdaloid*, or *almond-shaped*, or *tonsillitic lobe*, is anterior and internal to the last, is overlapped by the medulla oblongata, and projects into the posterior and lateral part of the fourth ventricle; these two lobes bound the sides of the valley anteriorly, and are connected to each other by the transverse laminæ of a lobule of the inferior vermiform process, called the spigot or the uvula.

The *flocculus*, or *pneumogastric lobe*, is situated anterior to and distinct from the hemisphere, by the side of the valley, and is connected by a delicate white stalk to the crus cerebelli. Close to and behind the par vagum, and below the facial and auditory nerves, it is marked with many transverse striæ, and can be detached all around except at its root It is connected to

its fellow by the *inferior* or *posterior medullary velum* (so called in contradistinction to the valve of Vieussens, or superior medullary velum); this is an exquisitely delicate membrane, composed of transverse fibres of white neurine, of a semilunar form, not unlike that of one of the venous or arterial valves; its convex edge is attached to the crus cerebelli, just below the origin of the valve of Vieussens; its concave edge is loose in the fourth ventricle, which cavity it assists in closing inferiorly; it extends to the flocculus lobe externally, thence it leads backwards, inwards, and downwards, in front of the pointed extremity or lobulus of the inferior vermiform process, which is called the nodulus; it passes in front of this, adhering to it behind the ventricle, and is continuous with the velum of the opposite side. This fine and semi-transparent nervous membrane is a sort of commissure between the two flock lobes and between each of these and the nodulus in the centre. If the fourth ventricle be opened either from above, or, what is better, by a vertical section through the middle lobe of the cerebellum, the nodule, of its dark red color and with transverse striæ, will be seen at the bottom of the cavity projecting upwards and forwards into it; also on either side are two small vascular folds or choroid plexuses. If we gently push these to one side, we obtain a view of this inferior medullary velum, loose and floating; it can be placed on any black substance, or the handle of the knife, and presents a beautiful example of white nervous membrane, semi-opaque like the retina, and, though not so strong, very similar to the valve of Vieussens. These two semilunar folds, with the nodule in the centre and the amygdalæ at the side, bear some resemblance in form to the velum and uvula palati.

The *middle lobe of the cerebellum* presents a superior and inferior surface, which are named the superior and inferior vermiform process or lobe. Some consider this portion of the cerebellum as a commissure between the right and left hemispheres, analogous to the corpus callosum in the cerebrum; I would rather view it as the primitive or fundamental element of the whole organ, and the hemispheres as lateral additions to or expansions from it, and that the true commissural fibres in the cerebellum are, first, the arched fibres, forming the anterior layer of the pons, analogous to the great cerebral commissure; second, the processes a cerebello ad testes, with the valve of Vieussens, or superior medullary velum; and, third, the inferior medullary velum. The first is the analogue of the corpus callosum, the second and third of the anterior and posterior commissures, while the second may also serve as an intercerebral commissure between the cerebellum and cerebrum. The *superior median lobe*, or vermiform process, extends from the anterior to the posterior notch, is very prominent before, but bevelled off behind nearly on a level with the hemispheres. The anterior eminence overlaps the valve of Vieussens, and is in contact with the quadrigeminal mass. It is marked by transverse lines, continuous with but fewer in number than those of the anterior square lobes on either side. These lines and laminæ appear longer than the space they have to cross, and, being bent in a tortuous manner, have been likened unto the segments of the annulosa, and hence the name of vermiform process. They seem to be curved or drawn forward, and are concave posteriorly, and this may account for the prominence in front. The laminæ of the posterior or semilunar lateral lobes meet behind this process in the transverse bands at the bottom of the posterior notch, and which some consider as the posterior commissure of the cerebellum. This superior lobe consists of a white stem, continuous with the central nucleus of the cerebellum; this branches out into numerous fine lines, one for each lamina, in which it is covered by the gray neurine.

The *inferior median lobe*, or *vermiform process*, is deeply sunk in the valley. At first view the latter would appear to separate completely the two hemispheres, but when it has been expanded we shall perceive that the laminæ

of opposite sides are continuous through the transverse but tortuous lines on this lobe in the same manner as above. This lobe appears much compressed in the valley, and pushed downwards and forwards against the medulla oblongata, so as to inclose the space between both, named the fourth ventricle. When fully exposed, it presents a cruciform shape, one point is superior and posterior in the posterior notch; the opposite or the anterior inferior one is in the ventricle, and its lateral broader extremities are connected with the inferior lobes of the hemispheres; the entire is marked by tortuous, transverse lines; the anterior are convex forwards and concave behind, and the posterior are concave forwards and convex behind. The posterior part of this lobe is in the posterior notch, and is continuous with the superior median lobe and with the posterior semilunar lobes of each side. In front of this it presents a series of prominences or lobules, one before the other: the first or most posterior is named the *pyramid*, thick and prominent, pointed downwards and backwards, marked by several curved transverse lines, which are continuous with those of the gracilis and digastric lobes of either side. Anterior to this is the second lobule, named the *uvula* or *spigot*, pointed downwards and forwards; it assists in forming the back of the ventricle, between the tonsillitic lobes, with whose laminæ it is continuous. Anterior to this is the *nodulus*, the terminating point of the inferior median lobe; it is a pointed, furrowed lobule, extending into the ventricle, and closing it inferiorly; it is connected to the flock lobes by the inferior medullary velum, which extends in front of it; on either side it pushes into the cavity a small fold of pia mater, called the choroid plexuses of the fourth ventricle; these are frequently studded with small cerebral granulations or corpora Pacchioni, and with fine calcareous particles.

The cerebellum then presents the following divisions and subdivisions: first, it is divided into three parts, viz., right and left hemisphere and middle or primary portion; second, each of these is subdivided by the horizontal groove into superior and inferior; third, the upper surface of each hemisphere presents two lobes, the anterior or square, the posterior or semilunar; the two former are connected by the tortuous, transverse laminæ of the superior vermiform process, and the two posterior by those forming the floor of the posterior notch; fourth, the median portion presents the single or azygos superior median lobe or vermiform process; fifth, the inferior surface of each hemisphere presents five lobes: most anterior and distinct from the hemisphere is 1, the flocculus or pneumogastric lobule, connected to its fellow and to the nodule by the inferior medullary velum; 2, the tonsillitic lobe or amygdala, on the side of the ventricle, and connected to the opposite through the uvula or spigot; 3, the digastric; 4, the gracilis; both of these are continuous with the opposite through the pyramid; 5, the semilunar, which is joined to its fellow by the convex transverse laminæ at the bottom of the posterior notch. The inferior median lobe, or vermiform process, presents from before backwards three lobules: the nodule, most anterior; next is the uvula or spigot; and most posterior is the pyramid. The valley, with the posterior notch leading into it, has been named by some the purse-like fissure; and the fossa behind the inferior velum, and in front of the nodule and uvula, has received the fanciful title of "nidus hirundinis."

The *fourth ventricle* is usually described in connection with the cerebellum, though in reality it does not properly belong to it; it is rather a space between it and the back of the medulla oblongata, closed in by the apposition and approximation of the surrounding parts, which gradually takes place through the successive stages of development and growth; it is situated between the pons and medulla oblongata in front, and the median lobe of the cerebellum behind, and its hemispheres on either side; it may be opened into from above by dividing the velum or valve of Vieussens, or more fully dis-

played by a vertical section through the median lobe, or it may be examined from below without any injury to the surrounding organ by merely dividing the arachnoid as it passes from the cerebellum to the posterior surface of the spinal cord, and raising the nodule and uvula, and divaricating the tonsillitic lobes. When fully displayed it appears an extensive space, about an inch and a half in length, and nearly the same in breadth in its widest portion; it is of a lozenge or diamond form, being much expanded laterally about its centre; this figure, however, is only well seen on its anterior wall; the superior point or angle is in the iter or aqueduct of Sylvius; the inferior point is between the posterior columns of the spinal cord, or the commencements of the corpora restiformia; this point or groove is closed by membrane, but is really the continuation of the posterior median fissure of the cord; the lateral points or angles are much elongated, and extend into a depression in the cerebellum, which will be found, when a vertical section of either hemisphere has been made, to correspond to the internal point of the corpus dentatum, or the cerebellar ganglion; the whole chamber is curved, convex upwards and backwards; its anterior wall, which is also inferior, is the posterior surface of the medulla oblongata and of the pons, the ascending columns of the former causing lateral projections or convexities in the latter; between these is a median groove, sharp and very distinct; this is the posterior median fissure of the spinal cord, which is continued upwards through the iter or aqueduct of Slyvius, then through the third and fifth ventricles, and becomes the great fissure between the cerebral hemispheres; this groove being closed below into a narrow point, has been resembled to a writing pen, and is named *calamus scriptorius;* on either side of it, in its lower half, white striæ are visible through a thin coating of gray matter, these are the origins of the portio mollis nerve; the posterior wall is arched, and is formed from above downwards by, first, the valve of Vieussens, and the processus a cerebello ad testes; second, by the median lobe of the cerebellum; third, by the uvula and nodulus, and partly by the tonsils, which rather lie on either side; and lastly, by the inferior medullary velum, which extends on either side from the nodule to the flocks; inferiorly it is closed, partly by the apposition of the nodule and velum, and choroid plexus, to the back part of the medulla oblongata, partly by the lining membrane of the cavity, and externally by the tense and constricted arachnoid, beneath which is the pia mater, which in this situation, after having sent inwards its choroid processes, assumes much of a fibrous character, and adheres closely round the top of the spinal cord, so that no communication normally exists between the ventricles and the spinal sub-arachnoid space; the sides of the ventricle are but the lines of junction between the anterior and posterior walls, and are formed by the white central nuclei of the hemispheres; the interior is lined by an exquisitely delicate membrane, which can be demonstrated by carefully scraping off the valve of Vieussens. The greater portion of the cavity is coated over with gray neurine like the third ventricle, and a larger quantity of this exists about the striæ, on each side of the calamus, and is probably ganglionic to the auditory nerves.

Although the surface of the cerebellum is wholly cineritious, except at the bottom of the horizontal and of the primary sulci, yet internally it consists of one mass of white substance, continuous from one hemisphere to the other, but more abundant in the lateral regions than in the middle; if the whole of the upper surface be sliced horizontally, as in the dissection of the cerebrum, we shall soon expose this central white nucleus, surrounded by a laminated line, broken and interrupted, and very unlike the undulating border around the cerebral centrum ovale. Such a section, however, gives no correct notion of the course of the white fibres to the laminated cineritious coating; to acquire this, make two vertical sections, one through the median lobe and di-

rectly in the middle line, and one through either hemisphere, carrying it obliquely through from before backwards and outwards; it may be made through its axis, but in order to expose one peculiar substance, called the corpus dentatum, it is better to make this oblique vertical section in the line of union of the internal, and of the middle thirds, so that two-thirds of the hemisphere will be to the outer side. The surfaces of the vertical section of the middle lobe present a very beautiful and delicate arborescent appearance, which has received the name of the *middle arbor vitæ*, a white central stem dividing into numerous fibrils which are distributed to the lobules, and laminæ, corresponding to the lines upon the surface; the section of either hemisphere presents the same beautiful and elaborate appearance, but on a larger scale; the central white trunk of this *lateral arbor vitæ* is short and thick, and sends off large branches to the primary lobes, each of these subdivides again and again into smaller twigs, which like leaf-stalks enter each a separate lamella, and are all coated over on their extremities and sides by gray neurine and vascular membrane. Such a section exhibits, not only the quantity, but also the wonderful superficial extent of the gray matter; also, how it covers three sides of every lamina, and lines every sulcus. If the incision through the hemisphere have been made as directed, there will be seen in the inner third of the central white nucleus in each hemisphere, and nearer the upper than the lower surface, a small, yellowish substance, named the corpus rhomboideum, or *dentatum*, or the ganglion of the cerebellum; it is the color of box-wood, and is surrounded by many bloodvessels; it is composed of a capsule of gray neurine, curiously involuted, or folded and plaited in and out, not unlike the convoluted surface of the cerebrum; the capsule is filled with white fibres, plexiform, and intermingled with gray matter prolonged from its surface; the capsule is convex posteriorly, but is open inferiorly and anteriorly, and the greater portion of the corpus restiforme enters it; the course of the fibres is then altered, they become confused and intermingled with the gray matter, and from all other points of the capsule the white fibres mingle in the central stem. The central white nucleus of the cerebellum is connected to the medulla oblongata, mesocephale, and cerebrum by three processes or peduncles on each side: one is the superior peduncle, or processus a cerebello ad testem; the second is the anterior peduncle, or the crus cerebelli; and the third is the inferior peduncle, or corpus restiforme, or processus a medulla oblongata ad cerebellum.

The *processes a cerebello ad testes*, are two thick, white, fibrous bands commencing in the central white nucleus of each hemisphere of the cerebellum; thence they ascend obliquely inwards, attached to and above the crus cerebelli, they join the testes, also the optic thalami, and the olivary tracts, passing through these; the valve of Vieussens, or the superior medullary velum, extends from one process to the other, is of a triangular form, the base is continuous with the white central nucleus of the middle lobe, its apex is attached to the angle between the testes, a narrow transverse band crosses and strengthens the attachment; the valve of Vieussens, and the process on either side may be considered as commissures, not only between the two hemispheres and the median lobe, but also between the cerebellum and cerebrum, and might be named the intercerebral or cerebro-cerebellar commissure.

The second or anterior peduncle of each side is the *crus cerebelli;* this a thick cord, larger than either of the other peduncles, it commences in the floor of the horizontal groove, passes forwards and inwards, and is continuous with that of the opposite side in the anterior layer of the pons or mesocephale; the two crura by this junction form what has been named the great commissure of the cerebellum.

The third or inferior peduncle is the *corpus restiforme*, which is continued from the posterior column of the medulla oblongata, to the cerebellum;

these three peduncles are all combined in the central nucleus, from which the several branches proceed to the different lobes and lobules; these three constituents of each crus cerebelli must establish intimate relations between the cerebellum and the spinal cord, the medulla oblongata, the quadrigeminal mass, and the optic thalami, and, through the latter, the cerebral hemisphere. As to the mode of connection between the white fibres and the gray matter, nothing more is known than in the cerebrum; the gray substance is of a darker hue, and apparently more vascular, than in the cerebrum; a section of it presents different shades, the external layer is the darkest, the middle the lightest, and the internal, of a median color, the thickest. The next and last division of the encephalon is the following.

SECTION IV.

DISSECTION OF THE MEDULLA OBLONGATA.

The *medulla oblongata*, or *spinal bulb*, is that conical portion of white substance which extends from the lower margin of the pons to the spinal cord, on a level with the ring of the atlas; its upper end or base, though apparently limited by the pons, is prolonged upwards through it to the crus cerebri of each side; inferiorly, there is no distinction between it and the spinal cord, posteriorly or laterally; but anteriorly, some decussating fibres have been fixed on, perhaps rather arbitrarily, as the bounding line; it is flattened before, and more so behind, it is round or convex upon the sides, is placed obliquely and a little curved, the base being anterior and superior, the apex inferior and posterior, it corresponds to the basilar process, the foramen magnum, and atlanto-occipital ligaments, and is embraced and partially concealed posteriorly and laterally by the anterior notch, and by the inferior median and lateral lobes of the cerebellum; the latter must be removed or held aside to expose its posterior surface; anteriorly no dissection is necessary except the careful removal of the loose arachnoid, and of the closely adhering pia mater: it presents an interior and posterior median fissure which divides it into two symmetrical portions, each of which is marked by three grooves and four convex eminences, viz., the anterior pyramids; on either side of these are the olivary bodies; still more laterally and posteriorly are the restiform bodies; and the posterior pyramids are on either side of the posterior fissure. The *posterior fissure* is continuous with that of the spinal cord below, and with the calamus scriptorius above; it is narrow, and sinks in deep to the anterior commissural fibres; the pia mater lines it. The *anterior fissure*, the continuation of the spinal, is broader, but not so deep, and is closed by transverse, cribriform, commissural fibres; nearly an inch below the pons this fissure is interrupted by those remarkable fibres called the *decussating fasciculi;* to see these, remove the pia mater, and gently separate the pyramids; they consist of three or four fasciculi which ascend obliquely inwards from the lower end of each pyramid to the opposite one, interlacing or indigitating with each other; this apparently trifling anatomical fact is of much physiological and practical interest, as it serves to explain the frequently observed phenomenon of injury or disease, in one side of the brain, being attended with loss of nervous power of some portion of the opposite side of the body; it should be observed too, that as the whole of the pyramids do not decussate, we can thus account for exceptions to this statement.

The *anterior pyramids* are two narrow, convex, white bands, about an inch long, small inferiorly, in contact and partially united by the decussating fas-

ciculi. Each arises narrow and rather abruptly at the seat of decussation, by two sets of fibres, one from the inner side of the opposite anterior column of the spinal cord, the other from that of its own side; as they ascend they become convex and prominent in the centre, and a little divergent, round, and constricted by the pons at their upper end, and separated by a central depression in the median fissure, called foramen cæcum; through the pons they can be traced upwards, intermingling with its gray neurine, and crossing its white at right angles, into each corresponding crus cerebri. The anterior pyramids appear to be the direct, as well as crossed medium of connection between the anterior fibres of the cord, the mesocephale, crura cerebri, corpora striata, and cerebral hemispheres, and partly also with the optic thalami.

The *corpora olivaria,* or *olive-shaped bodies,* are smaller and shorter than the pyramids, are external and a little posterior to them, and separated by a groove both from them and the restiform; they only exist in man and quadrumana; they are white and fibrous on the surface, but when divided they present a mass of gray neurine, called *olivary ganglion* or *corpus dentatum;* the latter name is from its resemblance to the so-called substance in each hemisphere of the cerebellum; it is an oval capsule of gray neurine, plaited or convoluted all around except on its inner side, where it is open and continuous with the central gray neurine of the medulla oblongata; it is not perfectly insulated either above or below, but is continuous with the gray matter of the pons, and with that of the medulla spinalis; the fibres of these bodies are named the olivary tracts, and, though apparently insulated, yet are continuous with the central portion of the medulla oblongata, and united with each other, as may be seen if the pyramids be dissected out and removed; the olivary tracts will then be found to ascend beneath or behind these bodies, and may be traced upwards through the pons, to the posterior part of the crura cerebri, and then to the optic thalami and tubercula quadrigemina; in this course they form a projection posteriorly on the floor of the fourth ventricle, on each side of the calamus scriptorius, and present a gray surface from which the auditory nerves arise. Beneath, and partly inclosing each olive are some curved fibres, concave upwards, termed *arciform;* they are very variable in number, and size; they appear to arise from the pyramid, then pass round the olive, and are lost upon the restiform body, sometimes they are expanded over a great portion of each olivary body, and in some cases are highly developed, and would appear like some of the lower transverse fibres of the pons drawn downwards; they are probably commissural between the three eminences to which they are connected.

Corpora restiformia, or the *ropes,* or *inferior peduncles of the cerebellum.* These are two thick, longitudinal, white cords, on each lateral and posterior aspect of the medulla, separated from the olives by a groove in which the roots of the eighth pair of nerves are lodged, and from each other by the posterior median fissure of the cord inferiorly, and by the fourth ventricle superiorly, which space they in some measure form by their divergence; they are best seen from behind, the inferior median lobe of the cerebellum having been removed; each is perfectly continuous inferiorly with the posterior and antero lateral columns of the cord; as they ascend they diverge, and thus increase the breadth of the medulla, and bending a little backwards, enter the hemisphere of the cerebellum, and join the inner surface of its crus at the lateral angle of the ventricle, and just below the ganglion dentatum, which they enter; they are crossed by the choroid plexus, the auditory nerve, and the pneumogastric lobule; their outer margin is a little concave: their inner margins are separated by the calamus, the olivary column, and the posterior pyramids; superiorly each is entirely expended in the cerebellum, inferiorly its fibres descend in two fasciculi, one to the posterior, the other to the antero-lateral column of the cord; the continued line of the posterior spinal nerves

separate these tracts; each restiform body connects the spinal cord and medulla oblongata to the cerebellum.

Posterior pyramids are two long, narrow columns, which extend on each side of the posterior fissure of the cord to its lower extremity; they are seen on each side of the calamus scriptorius in the lower part of the ventricle, and terminate abruptly; by their deep surface they appear continuous with the posterior part of the olivary tracts.

The medulla oblongata would appear to be a very important segment of the cerebro-spinal axis, it is in itself a sort of ganglionic centre communicating with all other parts; several nerves also are connected to it; the ninth pair arise between the olives and anterior pyramids; the eighth between the olives and the ropes; the auditory by the side of the calamus from the olivary columns; the sixth between the anterior pyramids and the pons; and the roots of the fifth also can be traced into the olivary tracts. The last division of the nervous centre is the spinal cord; this we may now examine, and then from it return to the encephalon, and unravel its structure from below upwards.

CHAPTER II.

DISSECTION OF THE MEDULLA SPINALIS, OR SPINAL CORD.

SECTION I.

DISSECTION OF THE MEMBRANES OF THE SPINAL CORD.

The spinal cord is inclosed or rather suspended in a cavity or canal much larger than itself, bounded by the bodies and processes of the vertebræ, and by their connecting ligaments; this organ, like the brain, is surrounded by three membranes, which are continuous with those in the cranium. Place the subject on the forepart, remove the soft parts covering the spine, and with the saw divide the crura of the spinous processes of all the vertebræ close to their articulating processes; then with the elevator raise the posterior arch of the spinal canal; a quantity of soft adipose and loose reddish cellular tissue, not unlike the marrow in long bones, and numerous venous plexuses intervene between the bones and the dura mater, which membrane is loosely connected to them, and cannot therefore serve the office of periosteum as in the cranium, but is closely attached anteriorly to the posterior ligament of the bodies of the vertebræ.

The *spinal dura mater* is termed the theca vertebralis; it is continued from the cranium through the foramen magnum, as a tubular process, down the spinal canal, as far as the sacrum, where it divides into several processes, which are continued on the sacral nerves; superiorly it adheres to the foramen magnum, and to the occipito-vertebral ligaments, inferiorly a delicate fibrous band connects it to the sacrum and coccyx; the sacral canal is chiefly occupied by the fatty matter before alluded to; its external surface is smooth and shining; throughout this extent it regularly sends off a tubular process along each of the spinal nerves, but when opened, it will be seen that each nerve escapes by two foramina, or small vertical slits, only separated by a narrow fibrous slip. The theca vertebralis is larger and longer than the cord it incloses, and is very loose below, where fluid is generally collected; it is dilated in the cervi

cal and lower dorsal regions, and contracted in the middle dorsal, thus conforming to the shape of the cord; it is fixed and retained in a certain state of tension, by its attachment to the vertebral ligaments in front, to the foramen magnum above, to the sacrum below, and on either side by the sheaths which are prolonged on the nerves, and which are gradually lost externally; it is not exactly in the centre of the canal, but is nearer to the bodies of the vertebræ than to the posterior arches, therefore nearer the axis or centre of motion of the column. Its arteries are derived from the occipital, deep cervical, vertebral, intercostal, lumbar, and sacral; its veins partly accompany these through the intervertebral foramina, and partly join the two *long vertebral sinuses;* these extend from the occiput to the sacrum, are placed on the lateral and back part of the bodies, and parallel, covered by the thin external margin of the anterior ligament, subject to alternate enlargements and contractions, and communicating regularly with each other by the *transverse branches* or *sinuses,* which lie between the ligament and the body of each vertebra; these transverse sinuses are dilated in the centre, they may be seen very distinctly in the cervical and dorsal regions; they cover the foramen or the fossa in the bone, and each receives from it two or three branches which traverse the spongy texture of the bodies of the vertebræ, and which are very similar to the diploic veins in the cranium; these have been named the *basi-vertebral veins* by Breschet. Each of these longitudinal sinuses in the vertebral canal bears an analogy to the inferior petrosal and cavernous sinuses in the cranium; and the transverse in the former, to the circular and transverse occipital in the latter; the longitudinal inosculate superiorly with each lateral sinus near its termination, and through their whole extent with the external spinal veins, through the intervertebral and sacral foramina. With the scissors divide this membrane along its whole length; its internal surface is smooth and lined by the reflected layer of the arachnoid or serous membrane; on expanding its sides, we see the spinal nerves on each side passing through it by the double row of holes, also the series of pointed or tooth-like processes of the ligamenta dentata inserted into it laterally between each pair in the neck and back, also, the semilunar fold of the arachnoid passing from one to the other, so as to form one continuous festooned border on each side from the occipital foramen to the commencement of the cauda equina.

The *arachnoid* or the *serous membrane* in this region has a corresponding appearance to that in the cranium, with which it is continuous; it is, however, rather stronger, at least in some situations, and is more loosely connected to the pia mater, so that air or any fine fluid may be impelled between them; a quantity of serous fluid is also at all times interposed, and occupies this extensive sub-arachnoid space; so that either the arachnoid membrane must possess two exhalent and absorbent surfaces, or, as is most probable, this sub-arachnoid fluid must be derived from the pia mater or from the connecting sub-arachnoid cellular tissue. The parietal lamina adheres intimately to the dura mater, and is continuous with the visceral layer at the exit of every spinal nerve, and at the point of attachment of the ligamentum dentatum; as each nerve escapes, the membrane which accompanies it from the cord forms a small *cul de sac* at the orifice in the theca, and is then continued on the latter; inferiorly it extends to the cauda equina, ends in a *cul de sac,* or rather in several small ones on the nerves; in this situation it is very fine, and among the lower nerves it often appears as thin and transparent as soap bubbles. The interval between its two laminæ is the arachnoid cavity; this is a confined space, and the opposed surfaces are often in contact, and even agglutinated; we seldom find any fluid in it if the body be recently dead. Beneath the visceral lamina is the sub-arachnoid cavity or space, this always contains some fluid, and, if examined immediately after death, or if the canal be opened in a living animal, and the membranes punctured, it flows out in a

clear stream, and at first with a jet; this space contains a cellulo-filamentous tissue, in which the fluid is entangled, attached to the pia mater and arachnoid, more dense in the median line posteriorly where it forms a sort of imperfect or pectiniform septum; this is most distinct in the dorsal region; the cellulo-fibrous tissue is most abundant in the cervical region, there is little or none inferiorly, and there the arachnoid can be detached with great ease; this space also contains the *ligamentum denticulatum* of either side; this delicate and elaborate structure is a narrow, membrano-fibrous band extending along each side of the whole spinal cord; its superior pointed extremity is attached to the dura mater at the foramen magnum, in front of the posterior root of the sub-occipital nerve, and of the spinal accessory, and behind the vertebral artery and lingual nerve; it has a glistening appearance, and appears composed of a white fibrous band, which becomes enveloped by the arachnoid; each tooth-like process also contains a fibrous thread which is inserted into the dura mater; in the cervical region it often presents a yellowish appearance, like elastic tissue; its internal edge is straight, and connected to the pia mater along the side of the spinal cord in the space between the anterior and posterior roots of the nerves; its external edge is serrated and attached by several pointed processes, about twenty-two in number, to the internal surface of the dura mater, near the foramina for the passage of the nerves, and nearer the lower than the upper; the intervals between these processes increase as we descend; inferiorly it ends in a fine filament which joins the filiform termination of the pia mater, and is inserted into the dura mater, covering the sacrum and coccyx. The ligamentum denticulatum serves to separate the roots of the spinal nerves, also to connect or fix the spinal cord laterally, and so guard it against lateral concusssion or displacement.

The sub-arachnoid fluid answers the same purposes as in the cranium; it supports and bathes the roots of the nerves and the bloodvessels, fills up all inequalities on the surface, and sustains the visceral arachnoid lamina in contact with the parietal, and thus keeps the theca distended, and maintains a gentle and a yielding pressure over the whole organ; and, at the same time, by separating it from immediate contact with the parietes, effectually guards it against concussion or vibration in the ordinary motions of the body.

The *pia mater* in the spinal canal is more dense and fibrous, but less vascular, than in the cranium. It adheres so closely to the spinal cord as to appear to compress it, which is evident when the cord is cut across, or if pricked with a point, the neurine protrudes. Though not so uniformly vascular as it is on the brain, very large and tortuous vessels extend along its whole length. When very recent, it can be easily detached from the medulla, or if the latter be hardened by immersion in alcohol, it can be peeled off, when numerous shreds and vessels may be observed to pass from one to the other. It not only invests the cord, but it also sends a duplicature into it along the anterior median line; this is very distinct, as it supports the anterior spinal artery, and a longitudinal white fibrous band; posteriorly, a very delicate vascular lamina or tissue is also prolonged from it into the median fissure; it also forms a neurilemma for each nerve, more delicate than the spinal investment. The pia mater contracts inferiorly, and ends in a filiform process, at first tubular, which descends together with the ligamenta dentata to be attached to the sacrum; the external surface of this membrane is covered by the cellulo-vascular sub-arachnoid tissue, which is more like the cranial pia mater than the immediate investment of the cord itself, for the latter partakes much more of the fibrous character, and is compact, dense, and pearly; this distinction is better seen in some animals, where this fibrous envelope is even of a different shade of color; the peculiar dense or fibrous structure is very marked about the upper end of the cord, and is even prolonged upon the

medulla oblongata and crura cerebri, but is totally aosent on the cerebrum and cerebellum; this membrane in the spine serves the office rather of a closely fitting capsule for the organ than that of a vascular membrane as in the cranium; in the latter the gray neurine is superficial and the vascular membrane expanded upon it; in the cord the white matter is superficial, inclosing the gray, and the vessels penetrate to the latter through the fissures, chiefly through the posterior.

SECTION II.

DISSECTION OF THE SPINAL CORD.

The Medulla Spinalis is about a foot and a half long, extends from the atlas, where it is continuous with the medulla oblongata, as far as the first or second lumbar vertebra, and ends in a lash of nerves called *cauda equina;* this organ is almost cylindrical, but the transverse diameter exceeds the antero-posterior, and the whole is much smaller than the osseous and membranous tube in which it is inclosed. A deep narrow fissure extends along the median line posteriorly, and a broad superficial groove anteriorly; at first the medulla spinalis is rather contracted or smaller than the medulla oblongata; but from the fourth or fifth cervical to the first dorsal vertebra it is larger than in any other situation; it then contracts and is nearly circular through the upper and middle dorsal regions, and again swells out about the tenth dorsal vertebra into an oval bulbous expansion, which terminates in a point below, from which the filiform process of the pia mater, and the remains of the ligamenta dentata, with one or two veins, extend: this lower extremity of the spinal cord is sometimes round, sometimes bifid. The two enlargements of the spinal cord correspond to the origins of the largest nerves, viz., those to supply the upper and the lower extremities. The superior enlargement is greater than the inferior, no doubt because the sensibility of the upper extremity is greater than that of the lower, and its motor power more delicate and varied. The medulla spinalis consists of two symmetrical portions or columns united at the bottom of the two fissures by commissures.

The *anterior fissure* penetrates to nearly one-third of its thickness, into it a fold of pia mater enters, on this the anterior spinal artery runs in a tortuous manner, superficial to which is a distinct white, fibrous, longitudinal band extending from one end of the cord to the other, and attached to the edges of the groove; the floor of this fissure is closed by transverse white fibres with interstices for vessels; this is the *anterior* or *white spinal commissure,* analogous to the corpus callosum in the cerebrum; this fissure is more distinct above than below.

The *posterior median fissure* is very narrow, and unless the cord be very fresh, or hardened, is difficult to be seen; it sinks in very deep, nearly one-half, and a fine, imperfect lamina of the vascular membrane enters it; it is closed below by the meeting of the gray central neurine of each side; this is called the *posterior* or *gray spinal commissure,* and is analogous to the commissura mollis and intercrural lamina; this fissure, also, is more distinct above than below. On each column, or half of the cord, two lines may be observed corresponding to the anterior and posterior roots of the nerves; the anterior is so faintly marked as almost to escape notice, but the posterior presents a grayish tint derived from the internal gray neurine; this line is fixed upon for dividing each column into two smaller ones: all in front of this line is named *antero-lateral,* and all behind it *posterior column.* The first

then is bounded by the anterior median fissure in front, by this postero-lateral groove behind; the second is between this line and the posterior median fissure; on each side also of the latter, superiorly, is a slight groove or line which bounds the small columns, called posterior pyramids; these are distinct in the fourth ventricle, on each side of the calamus, but inferiorly they gradually taper off into the posterior tracts. Some anatomists consider these portions between the roots of the nerves as distinct columns, under the name of *lateral columns*, and Sir Charles Bell designated them "respiratory tracts." This name, however, is not now retained. According to some writers, then, the medulla spinalis is composed of eight tracts or cords, or four pair, viz.: first, the anterior, between the median fissure and anterior nerves; second, the lateral, between the roots of the nerves; third, the posterior, between the posterior nerves and the posterior fissure; and fourth, the posterior pyramids, close to this fissure, but only in the upper part cf the organ. This arrangement, however, does not appear necessary. The lateral grooves are very superficial, and there is no internal corresponding distinction or separation; it appears to me sufficient to consider the cord as divided, first, into two symmetrical portions, connected by the white commissure in front, and the gray behind; and second, each portion subdivided by the gray line corresponding to the roots of the posterior nerves, into two, the antero-lateral, or larger portion, extending from this gray line to the anterior median fissure, and the posterior smaller portion between this gray line and the posterior median fissure. It is to the antero-lateral columns, and to the gray neurine within them, that the nerves appear to be most connected, and they cannot be traced distinctly into either the posterior or anterior tracts; for this reason, also, there appears no good ground for calling the anterior tracts of the cord "motor tracts," or the posterior, "sensitive tracts," although the terms "motor" and "sensitive" may be correctly applied to the anterior and posterior nerves, which do possess these special endowments.

The *spinal cord*, being a great nervous centre, is composed of gray neurine and white fibrous substance; it is the latter only which forms the superficial longitudinal tracts alluded to. If the organ be rendered hard by immersion in alcohol, these bands can be peeled off and separated, or split up into very long fasciculi, though very frequently shorter fibres bend into the central gray substance; superiorly these decussate, not only those of opposite sides, but also those of each side, with those before and behind, so that a perfect interlacement takes place in the medulla oblongata, through which, however, they are continued, partly into the laminæ of the cerebellum, and partly through the crura cerebri into the ganglions of the cerebrum.

The office or function of these longitudinal fibres is internuncial; they transmit on the one hand the impression made on the nerves from without to the brain, or percipient organ within, where sensation exists, and on the other they carry from the brain the stimulus of volition to the various muscles of the body. These fibres, therefore, are either sensitive or sensiferous, and volitive or motiferous: their function is at once suspended if their continuity be broken or interrupted. The cord, however, besides being the mere transmitting medium of sensations from without, and of volition from within, is also an independent centre of nervous energy, and is capable itself of receiving and of retaining impressions, without the mind or the brain being conscious of, or sensitive to them; and it can also excite certain motions and muscular actions independent of volition, and even in opposition to it. These functions the cord can exhibit when all communication between it and the brain is interrupted or cut off. The capability or power of receiving impressions, without consciousness, has been termed its organic sensibility, but more properly its excitability; and its power of causing corresponding muscular actions without volition has been named its *reflex power*. The two phenomena taken

together constitute the *excito-motor function.* We shall allude to it again directly when speaking of the spinal nerves, and shall now only add, that inasmuch as experiments and pathology have proved that this function may and does persist, even vigorously, below the division of the longitudinal fibres, that is, below the seat of interruption between them and the brain, it is plain that it must depend upon the gray or ganglionic neurine of the cord together with the nerves which are inserted into it.

A transverse section of the cord will not only exhibit its symmetrical structure, but also the *gray neurine* in each column; this is of a lunated form, the concavity outwards, the convexity inwards, and connected to the opposite one by the gray commissure; the anterior cornu is thick, round, and short; the posterior is thin, sharp, and long, and reaches to the surface, forming the gray line along the posterior roots of the nerves. This gray neurine forms one continued track through each column, and extends upwards to the corpora striata and optic thalami, beyond which it cannot be traced; it, therefore, has no direct connection with the peripheral neurine in the cerebral and cerebellar convolutions; it is to be regarded as the ganglionic centre of each spinal cord or column. Transverse sections of the cord, in different regions, exhibit the relative proportion of the gray and white matter in each, as has been well represented in Arnold's beautiful Icones. In the dorsal region there is less gray than elsewhere; the cervical expansion presents the greatest amount of white substance, particularly in the antero-lateral columns; in this region also the posterior white pyramids are seen. In the lumbar, the anterior white columns are diminished, but not the posterior, and the gray substance is considerably augmented; the lumbar enlargement chiefly depends on this material, while the cervical is owing to the increase in the white. The small size of the dorsal portion is in conformity with the limited nervous endowments of the trunk; and the preponderance of gray neurine below most probably bears a relation to the excito-motory actions of the rectum and urino-genital organs, and even of the lower limbs, which actions are more remarkable in them than in the upper, where sensibility and voluntary motor power are more highly developed. The relative proportion of gray neurine is much greater in the infant, the very opposite to what has been remarked in the cerebral convolutions, the seat of the intellectual functions, which at that age are comparatively dormant, while the excito-motor, or reflex functions of the cord, are in full activity. In the spinal cord of fish, reptiles, and birds, there is a regular canal extending through the entire length, and partially closed in some places into a tube. The fourth ventricle is typical of this; in birds this canal is expanded into a rhomboidal space, like the fourth ventricle in the lumbar region; this can be well seen in the common fowl; in the human embryo this canal also exists, but in the progress of development it becomes closed by the approximation of the lateral columns, and the only permanent remains of it are the posterior median fissure and the fourth ventricle. If any arrest of growth occur, it will remain open and imperfect, of which condition spina bifida may be considered an example.

In addition to the spinal accessory nerves, which may now be seen to arise from each side of the medulla spinalis in the upper half of the neck by twelve or fourteen small filaments, and to ascend behind the ligamenta denticulata, the spinal cord gives origin to thirty-one pair.

SECTION III.

ORIGIN OF THE SPINAL NERVES.

The spinal nerves are symmetrical; there are thirty-one pair (some anatomists enumerate thirty, some thirty-two), which are divided into eight cervical, twelve dorsal, five lumbar, and six sacral. All these nerves arise and terminate nearly in a similar manner; each is a compound nerve, composed of two roots, an anterior and posterior, each consisting of several filaments. The *anterior spinal nerves* arise from the antero-lateral columns in the narrow groove which subdivides these into anterior and lateral tracts. The *posterior* arise in the posterior lateral groove or gray line formed by the posterior cornu of the central ganglion; the filaments of each unite into converging fasciculi, which again unite to form each root; those composing the posterior root are larger than those in the anterior, excepting in the case of the first or sub-occipital, whose anterior is larger than the posterior, the latter is sometimes wanting, or it may join the spinal accessory nerve: these two fasciculi or roots are separated from each other by the side of the spinal cord, and by the ligamentum dentatum; they then converge and proceed obliquely outwards and downwards to the dura mater, which they perforate distinctly by two small openings, which, however, are so close as to appear but one; each fasciculus receives a sheath from the dura mater; a small oval ganglion is then formed upon the posterior root; to the surface of this ganglion the anterior root is only connected; immediately on the outer side of this ganglion the two roots unite and intermingle, and form a single cord; this is the proper or compound spinal nerve. After a short course outwards this passes through the intervertebral foramen, and immediately divides into two branches, a posterior and anterior; the former is almost universally the smaller, except in the first and second cervical, and is distributed to the muscles and integuments posterior to the vertebral column; the posterior branch of the second is very large, is named occipital, and is the sensitive nerve for the back part of the scalp. The anterior branches of the spinal nerves are much larger; they enter into the several plexuses, cervical, brachial, lumbar, and sacral, and supply the muscles anterior to the spinal column, as also the extremities. The first cervical nerves ascend a little, the second are nearly transverse; the succeeding nerves are more oblique, and the lumbar and sacral are vertical, and form the cauda equina; the three or four last have their ganglions and subsequent divisions within the sacral canal; the roots of the cervical nerves are the largest, particularly the posterior; the dorsal nerves, except the first, are much smaller than the cervical, and more distant from each other; the anterior and posterior roots are nearly equal; the lumbar again increase in size, and are very close to each other, so as almost to conceal the cord; their anterior roots converge below, and nearly meet.

The connection of all the spinal nerves to the cord is mainly depending on the pia mater; in separating this the nerves are usually detached also, and under commencing decomposition they separate along with it; if, however, the examination be made with great care in a very recent specimen, the nervous filaments appear to be partly connected with the superficial fibres of the cord, and partly with the gray neurine within; the filaments, however, are of such exquisite delicacy and minuteness as to elude observation. Mr. Grainger, in his ingenious treatise on the spinal cord, describes the fibres of each root, when in contact with the cord, as separating into two sets; one ascend, and are lost in the white fibres of the antero-lateral columns of the cord; the other set sink into the sulcus, and bend at a right angle into the

gray neurine, and terminate in it in a mode that cannot be ascertained exactly, but which appears analogous to the connection elsewhere between gray and white neurine. I have not yet had the satisfaction of proving the entire accuracy of this statement, which, however, is rendered extremely probable, and is strongly supported by the physiological explanation it affords of the functions of the spinal cord and spinal nerves.

We have already alluded to the double office of this organ, the first that of merely transmitting or propagating sensation and volition, the second that of an independent nervous centre, presiding over the excito-motor function, in which impressions are made upon the cord, which excite or give rise to corresponding muscular actions, the former without consciousness, the latter without volition. This twofold origin, then, of each root of the spinal nerves is in perfect conformity with this twofold function, and beautifully harmonizes with the excito-motor theory; for as the cord is to be considered partly cerebral and partly spinal, so are the nerves which are attached to it partly cerebral and partly spinal; each nerve, therefore, instead of two roots, really has four, two anterior and two posterior; of the two posterior, one set join the ascending fibres, and may be named the sensiferous or cerebro-sentient fibres; these transmit sensations to the brain, the seat of consciousness and perception; the other set sink into the postero-lateral sulcus, and join the gray neurine; these are named the incident or excitor fibres, or true posterior spinal nerves. Of the two anterior roots, in like manner, one set join the longitudinal fibres, and are named the volition or cerebro-motor fibres; the other set sink into the antero-lateral groove, and join the gray neurine opposite to the posterior or incident fibres, with which, probably, they unite; these anterior fibres are named the reflex or spino-motor fibres; these, with the incident fibres behind, constitute the excito-motor system, or true and independent spinal system, while the anterior and posterior ascending or descending fibres form the cerebral portion of the cord, and constitute it so far only an appendix to the brain.

All the spinal nerves, therefore, are compound nerves; their roots also are compound, the posterior being composed of sensitive and incident fibres, and the anterior of volition or cerebro-motor, and of spinal or reflex motor fibres.

The course and distribution of the spinal nerves shall be examined individually afterwards. The student may next dissect the brain from below.

.SECTION IV.

DISSECTION OF THE BRAIN FROM BELOW.

The brain, medulla oblongata, and the upper part of the spinal cord, should be carefully removed from the subject; the brain, with the base uppermost, should then be placed in a shallow basin; the cerebellum and medulla oblongata will now fall a little backwards, and all the parts of the base of the brain will be exposed. Raise the pia mater from the forepart and sides of the medulla oblongata. The several eminences on this organ may be traced upwards to the cerebrum and cerebellum. To follow these the dissector should rather scrape and break the surrounding substance with the handle or with the back of the knife, than cut it with the edge. In the description of the brain already given, certain differences between the cineritious and the white substances have been stated; it is necessary to recollect that the former is soft and very vascular, and that the latter is fibrous. It was an opinion maintained by Gall and Spurzheim that the gray is the origin or

matrix of the white substance, and that the former is a secreting organ, and that the latter consists only of fine conducting vessels or filaments. This opinion, however, can only be adopted with modification; it is incorrect to say that the gray forms the white, inasmuch as the origin of both in general is coeval, and their growth concurrent; in some situations the gray precedes the white, but in others *vice versa;* the gray, therefore, can no more be said to form the white than the latter does the former, but both are created by the vessels of the vascular membrane in their appropriate situations. This remark, however, does not lessen the value of the other statements propounded by these distinguished writers, to whom science is more indebted for correct notions of the cerebral structure than to any preceding or subsequent anatomists, namely, that the gray substance is the source of power, and that the white fibres are mere eonductors. The great vaseularity of the former implies superior functional importance; it is always found augmented in quantity, or extended in surface, where nervous energy is exalted; and wherever white fibres enter it, they appear on leaving it to be increased in size, if not in number. The gray or ganglionic masses, then, though not strictly "formative," in the language of Gall, yet may, according to him, be termed "ganglions of nutrition or reinforcement, or supply." In the dissection of the encephalon from below, we speak of fasciculi ascending from the spinal cord to the different parts above; this language suits the desired brevity in description, yet is not, perhaps, strictly correct; at least, if we are to name the connecting fasciculi according to the direction in which their supposed properties are transmitted, we ought then to consider and designate the "sentient" fasciculi "ascending," and the "notor" "descending," and the "commissural" "converging." Such distinctions, however, though perhaps theoretically true, cannot be practically demonstrated, except in a few instances; one set of fibres cannot be distinguished from another, neither can the exact commencement or ending of any be ascertained. Those who set out on the principle of one part suceeeding to another in the process of development, have considered all the white fibres as arranged in two orders, one called "formative or diverging fibres," the other "uniting or converging;" the fasciculi, ascending through the medulla oblongata, form the concentrated root of the former; the several commissures are the resultants of the latter. The fasciculi, in their ascending and diverging progress, pass through ganglionie masses at various stages; in each of these they separate into fibres, which again divide into minute fibrillæ, the intervals being occupied by the vascular, gray neurine; in these bodies some fibres appear to end, others to eontinue their course uninterruptedly through, while in some a new order of fibres, commencing in these, are superadded. The principal masses of this order, are, first, the corpora dentata, in the olivary bodies, and the vesicular matter diffused in the upper part of the olivary tracts; seeond, the corpora rhomboidea, or internal cerebellar ganglions; third, the mesocephale, including the pons and quadrigeminal bodies; fourth, the locus niger in each crus cerebri; fifth, the optic thalami; sixth, the corpora striata; and seventh, the superficial laminæ or hemispherical ganglions of the cerebrum and cerebellum, convoluted on the former, laminated on the latter; each of these has been already noticed in the dissection from above. We shall now trace the spinal fasciculi through these upwards, and point out, as far as ean be determined, the connection and termination of each. The medulla spinalis has been described as a symmetrical organ, eaeh half consisting of the great anterolateral cord, and of a small posterior eord, and superiorly and posteriorly of two smaller fasciculi, named *posterior pyramids.* Proceed now to trace the columns; and, first—

The posterior pyramids.—These are two white fasciculi, commencing small in the dorsal region, and, increasing in size, they ascend on each side of the

posterior median fissure as high as the fourth ventricle or calamus scriptorius, when they disappear rather abruptly, partly joining the restiform bodies and partly sinking into the central substance or the olivary tracts. They cannot be traced isolated any further, and may be regarded as commissural between the spinal cord and the medulla oblongata.

The restiform bodies.—These white ropes are continuous with the posterior columns and with the posterior portions of the antero-lateral cords, and are joined by the arciform fibres from the anterior pyramids; each rope then ascends obliquely outwards, diverging from its fellow, enters the hemisphere of the cerebellum, and joins the under surface of the crus cerebelli. Divide the latter by a vertical incision, the rope may then be seen continued into the mass of gray substance named corpus dentatum, or the ganglion of the cerebellum; from the inner edge of this a narrow white fasciculus may be traced inwards towards the median line; it there unites with a similar process from the opposite side, and both divide into several fine branches, which radiate and form the vermiform process, or the primary lobe of the cerebellum; the peripheral extremities of these fibres are covered by cineritious substance, and present, when cut vertically, an arborescent appearance (middle arbor vitæ). The remainder, or principal portion of the restiform body, passes upwards and outwards through the corpus dentatum, and then divides into several processes or stalks, which diverge through each hemisphere and subdivide into finer branches, each of which is covered by the gray substance on the surface. A vertical section of either hemisphere presents also that arborescent appearance known by the name of lateral arbor vitæ. The converging or commissural fibres of the cerebellum are inferior and superior; the latter are very delicate and rather indistinct in their course; they consist of several fibres, which issue from the superficial gray neurine of the vermiform processes or median lobe, and unite in one broad lamina, which is thin in the centre (the valve of Vieussens) and thick at each side (processus a cerebello ad testem). These superior converging fibres form not only the superior or lesser commissure of the cerebellum, but also the intercerebral commissure, or that between the cerebellum and the quadrigeminal bodies. The inferior converging fibres are more distinct; they proceed from the superficial gray neurine on either hemisphere forwards and inwards, and form the principal portion of each crus cerebelli; they then pass transversely across the pons Varolii, and unite with those from the opposite side; thus the superficial laminæ, or transverse fibres of the pons, constitute the great or inferior commissure between the hemispheres of the cerebellum.

Anterior pyramids are continuous with the anterior columns of the cord, each partly with that of its own side, but principally, through the decussating fibres, with that of the opposite; as they approach the pons they are somewhat contracted. On entering this ganglion they separate into fasciculi, which intermix with its gray substance, and become considerably increased in size and number in passing through it; they then form the anterior and external two-thirds of the crura cerebri.

The *olivary tracts* may be well seen by dissecting off one or both pyramids, commencing from the decussating fibres and raising them through the pons to the crus cerebri; the olivary columns are continuous with the central part of the medulla oblongata, and extend to its posterior surface in the upper part of the fourth ventricle; inferiorly they are prolonged into the antero-lateral column; the projecting portion of each between the anterior pyramid and the restiform body is named the olive, and contains the small ganglion, or corpus dentatum; after passing the sulcus below the pons, each tract ascends through this body, above and behind the anterior pyramids, and separated from them by gray neurine, and some deep, transverse, white fibres; in this course their fasciculi open and divide minutely, intermingling with

gray matter, so that their vertical direction is not so obvious as that of the pyramids; they can, however, be traced upwards into the superior, posterior, and internal part of the crura cerebri, and are continued thence partly to the corpora quadrigemina, and partly into the optic thalamus and corpus striatum; in these ganglions it is difficult to determine their exact course, or to display the radiated arrangement as represented in the engravings of different authors. If the parts be very well hardened, we perceive a great quantity of white substance to pass from the thalamus, partly to the posterior lobes of the cerebrum, partly upwards and inwards towards the corpus callosum, but principally upwards and outwards into the posterior lobes of the cerebrum; the exact course and termination of the fibres then become very indistinct; it is, however, most probable that they extend to the convoluted gray neurine upon the surface.

Crura cerebri are the two short, thick, white fibrous cords extending upwards and outwards from the mesocephale or the pons to the two cerebral ganglions, the thalamus, and the striatum; they are connected to each other by the gray intercrural perforated lamina, are encompassed by the optic tracts, and are perforated by many bloodvessels; they are composed of three planes, two are superficial and one is deep-seated; the anterior inferior plane is directly continuous with the anterior pyramids, the posterior superior with the olivary tracts. Between these planes, which with a little care can be separated by following a sulcus which appears on their inner and back part, the third component stratum is placed. This is a mass of gray or rather very dark neurine (locus niger), of a semilunar form, like that in each spinal cord, the cornua pointed, looking backwards and forwards, and the convexity inwards, and feebly connected to the opposite by the intercrural lamina. The locus niger, or ganglion of the crus, is continuous superiorly with the gray neurine of the striatum and thalamus, and inferiorly with that in the pons, medulla oblongata, and in the lateral spinal cord, so that the gray or vesicular matter forms a continuous track on each side from the lumbar extremity of the cord to the cerebral ganglions or corpus striatum and optic thalamus; and this long track, which is differently shaped in different parts, in some diminished, in others augmented, has no connection with the superficial or cerebellar ganglions, except through the medium of the white or conducting fibres. Each crus cerebri is capped by the striatum and thalamus, which are ganglionic masses; into these the white fibres enter, and, although these bodies appear on the surfaces as two distinct organs, they are really blended together into one mass, and may be compared to that in any segment of the spinal cord. These two organs are but one great ganglion, swollen before and behind, and, like those in the spinal columns, are connected on opposite sides by their gray commissure (commissura mollis), and by their white (anterior and posterior commissures). The white fibres, on entering these cerebral ganglions, become separated and intermingled with the gray substance; in these some appear to terminate, or perhaps to commence, others appear plexiform, others can be followed through them; from their peripheral surface numerous fasciculi pass off, many of which appear to commence in it; the fasciculi then radiate in all directions, and constitute the greater portion of each hemisphere; one portion can be traced upwards, to form the inferior lamina of the corpus callosum. The anterior portion of each crus runs more directly through the striated body, and the radiation of its fibres is more evident than that of the posterior, which first enters the thalamus, and then partly passes through the striatum also. The inferior and anterior part of each crus is more directly in continuation with the anterior pyramids, which are the prolongations of the anterior fibres of the cord, or the motor tract. Along this line it is presumed that volition is principally, if not solely, transmitted; these fibres, then, might be considered as de-

scending; along them volition, emanating either in the hemisphere or in the corpus striatum, descends through the pyramids and through the decussating bands, principally to the opposite spinal motor track, and thence to the anterior or motor nerves of the opposite side of the system. The posterior segment of each crus, which passes through the thalamus and corpus striatum, is much larger than the anterior, and, being in direct continuity with the posterior portion of each spinal column, that is, the sentient or sensiferous tract, may be regarded as ascending fibres, along which impressions are conveyed to the brain, where perception and sensation are manifested. But to what part of the brain do these fibres extend? Do they end in the cerebral ganglions, or do they pass through these to the hemispherical or superficial ganglions, and do they end then in loops or plexuses with each other; or are they united to, or continuous with, the descending motor fibres? These are questions to which anatomy affords no answer; they prove a fertile source for speculation and hypothesis, which, however, we shall not pursue on the present occasion. Although we stated, in conformity with the generally received opinion, that the crus cerebri, like each half of the spinal cord, contains a motor and a sensitive column, with intervening gray neurine; yet it is by no means certain, either from anatomical examination or from experiment, that this statement is perfectly true; it is even questionable whether the anterior and posterior tracts in the spinal cord are motor and sensitive in a distinct and isolated manner, although the nervous roots are so: it is certainly probable that motor filaments may preponderate in one and sensitive in the other, but that these continue isolated up to the brain must be questioned by the anatomist who in vain tries to insulate each tract in the medulla oblongata, and finds it still more difficult to do so in the pons Varolii, and totally impossible in the thalami and corpora striata. I consider, therefore, both divisions of the crura cerebri to be compound cords, and to contain motor and sentient fasciculi, while I admit that the anterior portion is more directly derived from the pyramids and anterior spinal or motor tracts, and the posterior from the back part of each antero-lateral or sentient tracts. As the corpora restiformia are derived from the posterior and antero-posterior columns, and are also connected with the olivary and anterior pyramidal tracts, they must be regarded as compound bodies, that is, as consisting of motor and sentient fasciculi. A most intimate connection exists between the cerebellum and the other parts of the nervous centre, viz., the pons, tubercula quadrigemina, optic thalami, and spinal cord. These anatomical relations, as well as the results of experiments on living animals, lead to the conclusion that the function of the cerebellum is intimately connected with the muscular system; and that, according to Flourens, it has the power of co-ordinating the voluntary motions, which originate in other parts of the cerebro-spinal centre: there appears no good reason for adopting the opinion of Gall, that the cerebellum is the organ of amativeness or sexual instinct. As the white fibres diverge and radiate through each hemisphere from the corpus striatum and optic thalamus, they appear to be of different lengths, and thus partly afford a mechanical explanation for the uneven or convoluted surface which the investing gray lamina presents; the physiological design of which, however, has been already explained. If all the fibres were of equal extent, the surface of the cerebrum would be smooth; but, as some fall short of others, and all are covered by the gray substance, an uneven or convoluted surface is the result. From this gray substance, which covers the surface of each convolution, and lines the intermediate sulcus, the converging or descending and commissural fibres are described as arising, and thence passing towards the mesial line: the corpus callosum and the anterior and posterior commissures are supposed to be thus formed. In addition to these transverse processes there are several other parts which may serve as media of communica-

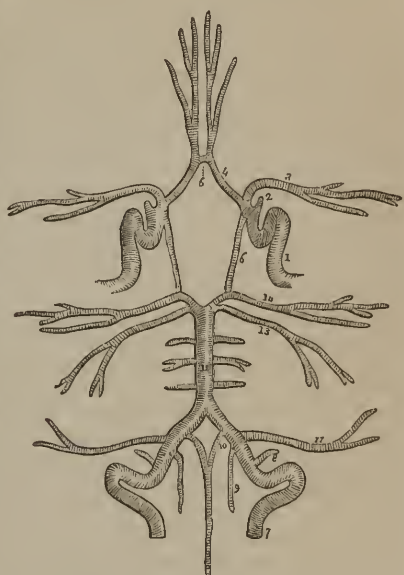
tion between different parts in each hemisphere of the brain, viz., the ourlet, the fornix, the tænia semicirculâris, the pineal gland, and its pedunculi, the infundibulum, the septum lucidum, &c. &c., all of which have been already alluded to.

SECTION V.

VESSELS OF THE BRAIN.

The brain receives a large supply of blood almost direct from the aorta, through the two vertebral and the two internal carotid arteries. The *vertebral arteries* are the first branches of the subclavians, and not unfrequently they proceed from the aorta itself; they ascend through the series of foramina in the transverse processes of the cervical vertebræ, anterior to the cervical nerves, winding around the superior articulating processes of the atlas, pierce the dura mater, and pass through the foramen magnum into the cranium; they then proceed obliquely forwards and inwards, and end in the common trunk called the *basilar artery*. Each vertebral first sends off two long and delicate branches, one on the anterior, the other on the posterior surface of the spinal cord; these extend the whole length of this organ, supplying it with blood, and sending out small branches along the several spinal nerves; next to these branches each vertebral gives off the inferior artery of the cerebellum; this turns backwards between the pneumogastric and spinal accessory nerves, and is distributed to the inferior surface of the cerebellum. The basilar artery ascends along the median groove in the pons, sending numerous branches into its substance, and at its superior edge divides into four branches, two for each side, viz., the superior cerebellar artery and the posterior cerebral; the superior cerebellar winds round the crus cerebri, parallel to the trochleator nerve, sends a branch with the seventh nerve into the internal auditory foramen, and is finally distributed to the upper surface of the cerebellum, and anastomoses with the inferior. The posterior cerebral arteries are much larger than the

Fig. 70.*



* The arteries of the brain and the circle of Willis. 1. The internal carotid artery. 2. The ophthalmic artery cut across. 3. The middle artery of the cerebrum. 4. The anterior artery of the cerebrum. 5. The anterior communicating artery. 6. The posterior communicating artery. 7. The vertebral artery. 8. One of the posterior meningeal arteries. 9. The posterior artery of the medulla spinalis. 10. The anterior artery of the medulla spinalis. 11. The inferior artery of the cerebellum. 12. The basilar artery, formed by the union of the two vertebral arteries. 13. The superior artery of the cerebellum. 14. The posterior artery of the cerebrum.

last, and separated from them at their root by the third pair of nerves; they are soon joined by the posterior branches of the carotids, and then wind round the crus cerebri parallel to the fourth nerves, send branches to the intercrural lamina, also into the crura cerebri, and are lost in the posterior cerebral lobes. Each *internal carotid artery* winds obliquely forwards, upwards, and inwards, through the tortuous canal in the temporal bone, and through the cavernous sinus; beneath the anterior clinoid process it perforates the dura mater, and rises perpendicularly to the base of the brain, between the second and third nerves, and then divides into three branches, the anterior, middle, and posterior, having first given off small branches to the cavernous sinus and to the dura mater, also the ophthalmic artery which enters the orbit through the optic hole, and is distributed to the eye and its appendages. The anterior branch of the carotid is also named the anterior cerebral artery, or the artery of the corpus callosum: this passes forwards and inwards, and is joined to the corresponding artery of the opposite side by a short branch (the anterior communicating artery); it then ascends, and runs along the upper surface of the corpus callosum, distributing its branches to the inner surface of each hemisphere. The middle branch of the carotid is the largest, passes upwards and outwards deep in the fissure of Sylvius, and is distributed to the anterior and middle lobes of the cerebrum; it sends branches through the perforated plate into the corpus striatum. The posterior branch of the carotid is named the posterior communicating artery; it is small, passes backwards, and joins the posterior cerebral artery; this forms the side of the circle of Willis. (*See* Anatomy of Vascular System). The vessels of the brain are accompanied by numerous fine filaments of the sympathetic nerves; these pass into its substance either to supply its intimate structure, or the minute vessels which permeate every part of it. The vertebral arteries receive their attendant nerves from the inferior cervical ganglions of the sympathetic, and the internal carotids from the superior; the branches on the carotids are more numerous and distinct. In the petrous canal and cavernous sinus they form a ganglionic plexus, which communicates with the cranial nerves of the orbit; from this the filaments can be traced along the trunk of the artery and its principal branches to the brain; on the anterior communicating branch the filaments of opposite sides unite in a small ganglion (the ganglion of Ribes). The arteries of the brain are remarkable for the freedom of inosculation, not only in their small branches, but in the trunks; the design of which is, doubtless, to secure a constant supply, notwithstanding any accidental interruption in any one particular channel. On the pia mater the arteries subdivide very minutely and inosculate most freely; the larger branches are lodged in the sulci, and the gray neurine is covered by a capillary network, branches from which enter into its tissue in infinite number and of exquisite minuteness. Intermingled with these capillaries are the gray vesicles and the fine fibrillæ of the white or tubular nervous matter, and there can be no doubt that the development of the nervous power is connected with the combination of these three elements, all of which are in a state of most minute division and intimate union. That the development and continuance of nervous energy greatly depends on the blood, may not only be inferred from these anatomical arrangements, but is proved by the actual experiment of completely cutting off the supply of blood from the brain being followed by a cessation of the force; an analogous result attends syncope. While a large supply of blood is indispensable to the brain, care has been taken to protect its delicate structure from the too strong impetus of the heart and large arteries; with this view, no doubt, have the curious contortions of the carotids and vertebrals been designed; the sub-arachnoid fluid also is well adapted to sustain, support, and compress the vessels, and to regulate the degree of vascular fulness; its importance in this respect is not merely

theoretical, but has been fully proved by the experiment of withdrawing it from the spinal canal in living animals, when the functions of the brain have become disturbed, and even syncope has ensued.

The veins of the brain join the sinuses, which have been already described; the principal veins are on the superior surface of the brain, whereas the large arteries are below.

The brain and its membranes exhibit many *morbid* appearances. The *dura mater* is sometimes found in a state of inflammation: to an inexperienced eye this appearance is difficult of detection, as in this condition very few more vessels appear carrying florid blood than in the natural state. In injuries from external violence, where inflammation follows, suppuration often occurs, and the pus is found sometimes on its external surface, between it and the bone, sometimes internally, covering the arachnoid coat. *Scrofulous and fungoid*, or *fibrous tumors*, growing from the dura mater, producing absorption of the bone, or pressure on the brain, are occasionally found; also deposition of bony laminæ, particularly in the falciform process, or near the superior longitudinal sinus.

The arachnoid membrane is sometimes inflamed. *Arachnitis*, when chronic, presents an opaque, or in some instances a thickened, state of the membrane, which gives it a tolerably firm consistence: serous fluid, sometimes of a gelatinous nature and creamy appearance, is found between it and the pia mater, and, although these appearances are said to depend on inflammation, still no vessels holding red blood are found ramifying on its surface, the redness which is sometimes present being owing to the vessels of the pia mater appearing through it. Adhesions between the parietal and visceral laminæ of this membrane seldom occur, as in other serous cavities. In acute arachnitis, pus, or sero-purulent fluid, or serum with lymphy flakes and of a sanguineous color, are occasionally effused.

Hydrocephalus is a disease of this membrane of frequent occurrence; it consists in an effusion of clear serous fluid; it may be acute or chronic, and the fluid, which may amount to a few ounces, or to as many pounds, may be collected either within the ventricles (hydrocephalus internus), or it may be on the surface of the brain (hydrocephalus externus); in the latter the brain will be found compressed towards the base of the cranium; in the former, which is the more common form, the hemispheres will be found expanded. In both the cranium will be enlarged, and in young persons the sagittal and coronal sutures will be expanded, and the fluid, in passing from one lateral ventricle to the other, raises up the fornix, expands the foramen commune anterius, and so passes into the third, and thence into the fourth ventricle. In hydrocephalus, scrofulous disease is frequently to be found at the base of the brain, as also small tubercles on the pleura and peritoneum. We often find fluid also between the arachnoid coat and the pia mater, sometimes effused in small patches between these two membranes, and at others over a large extent. When this sub-arachnoid, anasarcous-like effusion takes place, the vessels of the pia mater are found more distended with blood than usual, and the arachnoid membrane is often thick and opaque; it is not uncommon at the base of the cerebrum, and in the spinal canal; sometimes, but not always, there is effusion of water also in the lateral ventricles.

There is some difficulty experienced in distinguishing inflammation of the *pia mater*, on account of the great number of small vessels which naturally ramify on it. In the inflamed state these become much more numerous, and, by their anastomoses, make a beautiful reticulated appearance, not, however, causing such a general redness as may be observed in the inflammation of some other membranes; and, when the injury runs high, pus is formed, which is effused on the whole upper surface of the brain. A common morbid appearance, found in the pia mater, is the formation of small cysts, containing

water, which are generally called hydatids; these are found more usually on the choroid plexus, and in the velum interpositum. *Inflammation of the substance* of the brain is occasionally observed arising from external injury; the redness, which is generally slight, is confined to one particular part. In this state, when cut into, the color appears to arise from a great many small vessels, which are filled with red blood; the inflamed part is softer and more yielding than natural, giving rise to an appearance which has been described as "ramollissement." When the inflammation proceeds further, abscesses holding pus are sometimes formed, which, if of a large size, break down the substance of the brain, and present a very jagged appearance on their internal surface, though in some instances they have a regular cyst. *Apoplexy*, or an effusion of blood or serum either on the surface or in the substance of the brain, and occasionally into some of the ventricles, is also met with. The blood found in those situations is almost always black and coagulated; the substance of the brain is torn. When the person survives the attack, and recovers the energy of the organ, the blood becomes absorbed in part, a regular cyst or cell incloses the remainder, and in some cases no trace remains of the original disease, except some condensed or cicatrized appearance. *Deposition* of *caseous* and even of *earthy matter* in the arteries of the brain may also be looked for. This appearance is by no means rare, particularly in old subjects. Arising from this state of arteries, aneurisms of the internal carotids are described by some authors, but they are not of common occurrence.

SECTION VI.

ORIGIN OF THE CEREBRAL NERVES.

There are nine pair of cerebral nerves; their connection to the brain is named their origin; they are distinguished by the terms, first, second, third, &c. &c.: in every respect those of the opposite side are symmetrical, and they are all, except the olfactory, connected directly or indirectly with the medulla oblongata and mesocephale.

The FIRST PAIR, or OLFACTORY, are situated beneath the anterior lobes of the brain; each *arises* by three filaments; the *external*, very long and white, from the fissure of Sylvius, below the corpus striatum; the *internal*, also white, from the gray substance at the extremity of the corpus callosum; the *middle* is cineritious, and *arises* from one of the posterior convolutions of the anterior lobe. The three filaments soon unite, and form a triangular swelling, from which the nerve proceeds forwards and inwards for about two inches, in a groove between two convolutions on the under surface of the anterior lobe, in which it is confined by the arachnoid membrane, and protected from pressure; it then ends in a soft, gray, oval bulb, which is placed over the cribriform plate of the ethmoid bone, close to the crista galli; from this the several filaments descend through the foramina in this bone, and are distributed to the mucous membrane of the nose: these filaments, which are the proper olfactory nerves, are very fine and soft; they descend through the two rows of foramina in the cribriform plate; the internal set are distributed to the septum; the external to the superior and middle spongy bones. The olfactory differ from the other cerebral nerves in figure, course, and structure; in form they are prismatic or triangular, the apex being imbedded in the groove in the cerebrum; they converge as they leave the cranium; they consist of several striæ, some white, others gray, all very soft; they are not surrounded by arachnoid membrane, but lie above it; they have no distinct

sheath, and each ends in a soft, gray swelling, from which the ultimate filaments proceed, or truly arise, and then leave the cranium by a number of foramina. It would be more correct to consider the origin of these nerves to be from the bulbs at each side of the crista galli, and to regard these bulbs and their connecting stalks as appendages of the brain or *olfactory lobes;* these are composed of gray and white neurine; in the peduncle the gray is superior and the white inferior; the bulb is principally cineritious, but contains some white substance internally. In the sheep these organs are very large, and in each bulb there is a distinct cavity, with polished surface, communicating by a small canal with the lateral ventricle.

The SECOND PAIR, or OPTIC, are large, soft, and flat posteriorly, round and inclosed in a dense neurilemma anteriorly; each *arises* from the tubercula quadrigemina, from the optic thalamus, and from the corpora geniculata; the roots unite into a soft, flat band, which turns forwards in a semicircular course (*tractus opticus*) around the crus cerebri, to which it has but a slight attachment, and from which it receives a few fibres; the optic nerves then converge, and unite before the sella turcica in the *optic commissure,* or *chiasma.* In this flat, white, square substance, which is connected to and receives additional fibres from the tuber cinereum, the two nerves are so confounded that the direction of each is indistinct, but it appears as if the inner fibres of each decussate, while the outer fibres proceed on to the eye of the same side; from the commissure each nerve passes forwards and outwards on the inner side of the carotid and above the ophthalmic artery, through the optic foramen, into the orbit; it is there surrounded by a process of dura mater, which splits at the orbital surface of this foramen; its outer layer joins the periosteum of the orbit; the inner incloses the nerve as far as the sclerotic coat, with which it becomes continuous; the nerve proceeds to the back part of the eye, and perforates the choroid and sclerotic coats of this organ, and terminates in the retina.

The THIRD, or MOTORES OCULORUM, are smaller than the optic; each *arises* from the inner side of the crus cerebri, close to the pons, behind the floor of the third ventricle, and between the posterior artery of the cerebrum and the anterior artery of the cerebellum; the fibres can be traced into the crus to the mass of gray neurine named "locus niger;" this round nerve passes forwards and outwards external to the cavernous sinus, through the foramen lacerum orbitale, then divides into two branches, which are distributed to five of the seven muscles contained in the orbit.

The FOURTH, or TROCHLEATORES, or PATHETICI, are the smallest of the cerebral nerves; each *arises* by two or three delicate filaments from the valve of Vieussens, and from the processus a cerebello ad testem, or from the olivary tract; it takes a long course forwards and outwards between the cerebrum and cerebellum, enters a small canal between the layers of the tentorium, behind the posterior clinoid process, and continues its course along the outer side of the cavernous sinus, at first below the third, but it afterwards rises above all the orbital nerves, passes through the foramen lacerum orbitale, and is distributed exclusively to the superior oblique muscle.

The FIFTH, or TRIFACIAL, or TRIGEMINI, are the largest of the cerebral nerves; each consists of nearly one hundred fine filaments, but loosely connected to each other, and very easily detached from the brain, leaving a small nipple-like projection, which, however, is only the cerebral portion of the ruptured nerve. This large fasciculus obviously consists of two packets, one very large and inferior, the other much smaller and superior; the latter is motor in function, the former is sentient, and will be found to expand into a large ganglion (*Casserian*). Both portions issue from the crus cerebelli near its junction with the pons through transverse slits in the former; they are attached to the anterior inferior surface of the crus near its centre, but nearer

to the upper than the lower margin; the motor or smaller portion is at first superior to the sensitive, but it generally winds round it, so that when the latter expands into the ganglion on the petrous bone, the former is beneath it, and can be easily separated from it. The fifth nerve is considered analogous to the spinal system of nerves; like these it is compound in function, and consists of two portions or roots which spring from the spinal bulb; the posterior root or nerve also forms a ganglion in the middle fossa of the base of the cranium, and the anterior nerve is only connected to it, but does not enter into its structure. This ganglion divides into branches, which are extensively distributed to the head and face, and are the sentient nerves to these regions; the other, or anterior or motor root, is exclusively distributed to the group of muscles engaged in mastication. The point of attachment of this nerve to the crus cerebelli is the point of escape, but not of origin, as it can be traced downwards and inwards to a considerable depth, the two portions continuing distinct. In tracing it in this direction the fasciculi are found to become flat and soft, from having little or no neurilemma, as they have externally, and are, therefore, difficult to insulate or pursue, unless the parts have been previously hardened in alcohol, and even then considerable care is requisite; indeed it is by no means easy to determine the exact point or origin of the root; this accounts for the discrepancy in the description and representations in different anatomical works. Doctor Alcock has given the most elaborate and accurate description of all parts of this nerve in a very able article ("Fifth Pair of Nerves") in the *Encyclopædia of Anatomy*, from which the following is an extract: "The *larger packet* can be more easily traced; it descends beneath and before the smaller, inwards and backwards, towards the spinal bulb; it first traverses the middle crus of the cerebellum from before backwards and from above downwards; it is then situated in the angle formed by the three peduncles of the cerebellum at their junction with the hemisphere, behind the middle, beneath the superior, and above the inferior, and before or beneath the floor of the fourth ventricle. At this point it is attached to the medulla oblongata, very close to the interior of the ventricle, only separated from it by a fine lamina of epithelium, and superior to the auditory nerve, and separated from it by an interval of a few lines. The *lesser packet* is divisible into two roots, a superior and inferior; both traverse the crus as the greater does; the inferior in company with, and close to it, the superior is nearer the superior surface of that part, and is often so near the surface of the crus that it can be traced by the eye without dissection. In some cases the two fasciculi are separated from each other, and even intermingled with those of the crus; in such their pursuit is difficult and intricate, in others they pass as two distinct packets, and are more easily followed. As they proceed they approach the larger packet, and, having traversed the crus, are attached below and behind it to the same part as the great packet is. When the adjacent matter has been cleared away carefully, this part appears as a yellowish, longitudinal tract of fibres, which can be traced upwards and downwards; upwards it is continued beneath the superior peduncle of the cerebellum, downwards it descends from behind the pons into the spinal bulb, and soon divides into two cords, one for each column of the medulla spinalis. As this tract enters the spinal bulb it is situated deep before the floor of the ventricle and behind the superior attachment of the seventh pair; externally this tract corresponds to the peduncles of the cerebellum, and is united internally to the cineritious matter in the ventricle. At the point of attachment of the nerve, this tract presents an eminence which may be considered the origin of the nerve, although cords can be traced from this to more remote parts. The two parts or cords into which this tract separates have a remarkable course; the anterior is large, and descends to the inferior peduncle of the cerebellum, and joins the posterior spinal column external to the olivary body, but un-

connected to it; the posterior smaller cord descends behind the inferior peduncle, on the posterior aspect of the spinal bulb, enters the posterior fissure between the posterior pyramids, descends along it for some way, and joins the back part of the anterior spinal columns." From this statement, then, it would appear that the apparent origin of both roots of this nerve is from the eminence on the longitudinal tract, in front of the floor of the fourth ventricle and of the auditory nerve, and that this tract is connected inferiorly by two fasciculi to the anterior and posterior spinal columns. From this origin the two portions of the nerve may be traced upwards to the surface of the cerebellum, through the transverse slits in which they escape; the inferior or larger portion appears constricted by the fibres of the crus, and a transverse fasciculus separates it from the smaller portion. The entire nerve then passes outwards and forwards beneath the inner border of the tentorium, also beneath the superior petrosal sinus, and over a depression on the internal and anterior part of the petrous bone, through a large oval hole or canal in the dura mater, formed by the separation of that membrane into two layers; the nerve then expands on the surface of the petrous bone in the middle fossa of the base of the cranium into the Casserian ganglion: the nerve between the brain and the edge of the petrous bone is loosely enveloped by the arachnoid membrane, which also lines the foramen and fossa as far as the inner edge of the ganglion; it is then reflected on the parietes; each filament of the nerve possesses a distinct neurilemma of pia mater.

The *Casserian ganglion* is of a semilunar or triangular form, the apex internally in the nerve, the base is convex, and directed forwards and outwards; the superficial lamina of the dura mater adheres very intimately to it, and most probably receives some filaments from it. When this has been removed the ganglion appears flat and dark-colored, of a very plexiform structure, and the interstices filled with firm, dark neurine; if it be raised from the bone, the small white motor fasciculus will be seen attached to it so loosely as easily to admit of separation. From the ganglion three large branches proceed; the first, or ophthalmic, passes upwards and forwards, and enters the orbit through the foramen lacerum; it supplies the eye and its appendages with sentient filaments; the second, or superior maxillary, passes directly forwards through the foramen rotundum, and is distributed to the face, supplying it also with sentient nerves. The inferior maxillary is the largest branch, and is joined by the motor; this nerve, therefore, is a compound nerve: it descends directly through the foramen ovale; its motor portion is distributed to the muscles of mastication, and its sensitive to the tongue, lower jaw, lip, chin, &c.

The SIXTH, or ABDUCENTES, are of a middle size, between the third and fourth; each *arises* from the outer side of the corpus pyramidale a little below the pons, passes forwards and outwards, pierces the dura mater behind the body of the sphenoid bone, traverses the cavernous sinus on the outer side of the carotid artery, and is there joined by two or three small filaments from the superior cervical ganglion of the sympathetic nerve; it then enters the orbit through the foramen lacerum, and is distributed to the external rectus muscle; the root of this nerve may be traced through the pyramids into the gray neurine and olivary tracts; the basilar artery is between the nerve of the right and left side.

The SEVENTH PAIR consists of two portions, the PORTIO DURA, or the FACIAL NERVE, and the PORTIO MOLLIS, or the AUDITORY NERVE. The *facial* nerve is the smaller of the two, and is anterior and internal to the auditory; it *arises* from the lower edge of the side of the pons below the crus cerebelli, behind and above the corpus olivare, and in front of the restiform, through which its fibres sink into gray neurine, which probably brings it into communication with the roots of the fifth pair.

The *auditory nerve*, or portio mollis, is the posterior and the larger; it

arises by several striæ from the side of the calamus scriptorius, and from a small mass of gray substance on the back of the corpus restiforme; these unite into one soft, white cord, which passes forwards and outwards round the restiform body, and joins the portio dura; the two nerves then pass outwards, the mollis being larger than the dura; the latter is contained in a groove in the former, and a small bloodvessel runs between them; they both enter the meatus auditorius internus, where they soon separate. The facial nerve runs along the aqueduct of Fallopius, which opens inferiorly at the stylo-mastoid foramen; the nerve then turns forwards, and is distributed to the side of the face. The auditory nerve descends obliquely forwards, and is distributed to the cochlea and semicircular canals.

The EIGHTH PAIR, or PAR VAGUM, consists of three portions, the GLOSSO-PHARYNGEAL, the smallest; the PNEUMOGASTRIC, the largest; and the SPINAL ACCESSORY, which is of a medium size.

The *glosso-pharyngeal arises* by four or five delicate filaments between the corpus olivare and restiforme; these unite into one small nerve.

The *pneumogastric*, or the vagus, *arises* by ten or twelve filaments below the last, but in the same groove; these also unite into one nerve, which, with the glosso-pharyngeal, passes forwards and outwards to the foramen lacerum posterius or jugulare, where they are joined by the third portion.

The *spinal accessory nerve arises* from the side of the medulla spinalis, between the roots of the spinal nerves, by several delicate fibres, which commence a little above the middle of the cervical portion of this nerve; from this origin it ascends behind the ligamentum denticulatum, and very near the posterior roots of the spinal nerves; it frequently receives filaments from the roots of these nerves: having passed through the foramen magnum, it joins the other divisions of the eighth pair, the inferior artery of the cerebellum having previously passed between them. The eighth pair of nerves passes through the jugular foramen anterior to the vein, and immediately separates into its three portions, the particular course of each of which shall be considered afterwards. The spinal accessory is distributed to the muscles on the side of the neck; the glosso-pharyngeal to the pharynx and the tongue, and the pneumogastric to the lungs and stomach.

The NINTH, or LINGUAL NERVE, *arises* by six or eight fine filaments between the corpus olivare and pyramidale, and behind the vertebral artery; these unite and pass through the lingual or anterior condyloid hole in the occipital bone. The ninth pair of nerves are distributed to some of the inferior muscles of the neck, also to those of the tongue.

Nerves are either *simple* or *compound*. By simple, is meant a nerve possessed of but one property; by compound, a nerve possessed of two properties. The properties with which nerves are endowed, so far as we are positively informed, are two, viz., *sensation* and *volition*: nerves endowed with the former are called *sensitive nerves*; those with the latter are named *motor*.

Of the nine pair of cerebral nerves, some are simple, some compound; the simple are the first, second, third, fourth, sixth, and ninth; the first and second are simple nerves of sense; the third, fourth, sixth, and ninth, are simple nerves of motion. The fifth, seventh, and most probably the eighth, are all compound nerves; thus the ganglionic portions of the fifth are sensitive, while the non-ganglionic are motor; the portio mollis of the seventh is a nerve of sense, but the portio dura is motor. The peculiar position of the origin of the eighth from the side of the medulla oblongata and spinal cord, would imply that it partook of the double properties of these organs, that is, of their anterior and posterior surface, and that it is a compound nerve; accordingly, in experiments on living and on recently killed animals, irritation applied to the divisions of the eighth pair has in the former state of the animal produced pain, and in the latter muscular contraction.

CHAPTER III.

DISSECTION OF THE NERVES.

The course and ultimate distribution of most of the nerves have been already mentioned in the description of the muscles, and of the several regions of the body; in the present chapter they shall be considered in a systematic manner, commencing with the cerebral nerves, the origins of which have been already described.

SECTION I.

DISSECTION OF THE CEREBRAL NERVES.

I. Olfactory Nerves.—From the bulb, which each of these nerves forms at the side of the crista galli, several branches descend into the nose, through the foramina in the cribriform plane; they may be divided into the internal, middle, and external. The *internal branches,* about ten in number, descend in grooves along the septum, subdivide into many filaments, which form a plexus with each other in the mucous membrane; some of these can be traced nearly to the floor of the nose. The *middle branches* are distributed to the mucous membrane lining the roof of each nostril. The *external branches* descend along the grooves on the turbinated bones, dividing and communicating frequently with each other, so as to form numerous plexuses, which are lost in the pituitary membrane. All the branches of the olfactory nerves are very soft in the cranium, but, in passing through the ethmoid bone, they each receive a sheath from the dura mater, which is ultimately lost in the external layer of the mucous membrane.—(*See* the Anatomy of the Nose.)

II. Optic Nerves.—Each optic nerve, on passing through the optic foramen, becomes round, having previously been of a flattened form, and is surrounded by a strong sheath derived from the dura mater. It is next encircled by a tendinous ring, formed by the origin of the four recti muscles which surround it, from the fleshy portions of which it is separated by a considerable quantity of soft fat, in which several nerves and vessels are lodged. From the optic foramen this nerve proceeds forwards and a little inwards, so as to be slightly curved, the convexity outwards; at the back part of the eye it is very much constricted; it then pierces the sclerotic and choroid membranes, and terminates in the retina.—(*See* Anatomy of the Eye.) The ophthalmic artery accompanies this nerve; in the optic foramen it lies beneath it; it afterwards twines around it to its internal side. Near the sclerotic a small branch, named arteria centralis retinæ, pierces the sheath, and runs in the axis of the nerve to the internal surface of the retina, and to the hyaloid membrane. This will be seen in the dissection of the eye. In addition to the dura mater, this nerve possesses a fine but dense neurilemma, which sends in numerous processes to form small canals or tubes, in which the nervous substance is contained; so that this nerve is not composed, like the motor nerves, of several filaments placed parallel to each other. If the white substance be removed by maceration in an alkali, its tubular structure will become obvious.

At the side of the body of the sphenoid bone the following four nerves of the orbit lie, according to their numerical order, viz., most superiorly the third nerve, then the fourth, next the ophthalmic branch of the fifth, and most inferiorly the sixth, or the abducens nerve. They are here closely united to each other, and form what may be termed the *orbital plexus;* when they have arrived at the anterior clinoid process they separate, and, as they are entering the foramen lacerum orbitale, are related in the following manner: most superior is the fourth, then the frontal branch of the ophthalmic, next the superior division of the third, external to which, and near to the outer wall of the orbit, is the lachrymal nerve of the ophthalmic: below these are the nasal nerve and the inferior division of the third; and, lastly, lying inferior to all, and holding the same relation to them as it did at the cavernous sinus, is the sixth nerve; to this last the ascending branches of the superior cervical ganglion of the sympathetic nerve, which form the carotid plexus, are intimately connected, and several filaments from these can also be traced to the other nerves of the orbital plexus.

To expose these four nerves the orbit should be opened, which is to be done by dividing the orbital plate of the os frontis by two cuts with the saw; these should unite in the optic foramen; the internal is to be carried forward to the superciliary arch, about half an inch external to the internal angular process; the external incision is to be carried deeply through the malar bone; a slight blow of the hammer will then throw forwards the roof of the orbit, and the bone will separate easily from the periosteum, which is then to be carefully dissected off.

III. The THIRD NERVE, or motor oculi, in passing through the foramen lacerum orbitale, divides into two branches, a superior and inferior. The *superior,* or the *smaller,* passes between the heads of the external rectus muscle, above the optic and nasal nerves, and divides into two branches, the smaller and shorter one of which supplies the superior rectus, the other the levator palpebræ muscle. The *inferior,* or the *larger branch,* passes below and to the outside of the optic nerve, and divides into three branches, an internal, middle, and external. The *internal* is the largest; it passes obliquely downwards forwards, and inwards, beneath the optic nerve, and, getting to its internal side, is distributed to the internal rectus; the *middle* to the inferior rectus; and the *external,* which is the longest, passes downwards and forwards on the surface of the inferior rectus, between it and the globe of the eye (it gives no filaments to this muscle), and is lost in the inferior oblique muscle. This last branch gives off from its root a small, short filament to the ophthalmic ganglion. All the branches of the third pair are distributed to the ocular surfaces of the five muscles they supply.

IV. The TROCHLEATOR, or fourth nerve, having entered the orbit by the foramen lacerum, ascends obliquely forwards and inwards above the levator palpebræ and the superior rectus, and immediately beneath the periosteum; it is distributed by four or five fine branches to the upper or orbital surface of the superior oblique muscle. As this delicate nerve is passing along the outer side of the cavernous sinus, it lies between the third pair and the ophthalmic branch of the fifth, below the former and above the latter and the sixth; as it enters the orbit it mounts above the third and fifth; a fine filament usually connects it to the lachrymal branch of the latter; it is then the highest nerve in the orbit, both it and the frontal being immediately beneath the periosteum; previous to entering the oblique muscle its size is somewhat increased; while along the cavernous sinus it communicates with the ophthalmic nerve and with the carotid plexus of the sympathetic; from this latter communication some recurrent branches pass to the surrounding dura mater and to the tentorium.

V. The TRIGEMINI, or the fifth pair, having formed the semilunar or Cas-

serian ganglion, divides into three large nerves, viz., the ophthalmic, the superior, and inferior maxillary.

The Ophthalmic Nerve passes along the outer side of the cavernous sinus, below the third and fourth, and above the sixth. In this situation it receives some filaments from the fourth and from the sympathetic nerve. As it approaches the foramen lacerum orbitale, it divides into three branches, the lachrymal, frontal, and nasal, which are situated with respect to the other nerves as above described.

The *lachrymal nerve*, the smallest and most external of the three, usually anastomoses with the trochleator in the foramen lacerum; it passes forwards and outwards to the lachrymal gland, above the external rectus muscle, and beneath the periosteum, but gives no branches to the former; it is surrounded by fat, and accompanied by the lachrymal artery; it sends off, in this course, two small branches, one through the spheno-maxillary fissure, to communicate with the superior maxillary nerve, and the other through the malar bone, to communicate with the facial nerve. Near the gland the lachrymal nerve enlarges, and sends four or five branches to its inferior surface, and it then terminates in several fine soft filaments, which are lost in the conjunctiva, lining the superior palpebra, and in the cellular membrane between the lachrymal gland and malar bone.

The *frontal nerve* enters the orbit, between the superior rectus and the periosteum, along with the fourth, but inferior and external to it; it passes forwards on the upper surface of the levator palpebræ muscle, and near the superciliary arch it divides into two branches, an internal and external; the *internal*, or *supra-trochleator* nerve, the smaller branch, runs forwards and inwards above the trochlea of the superior oblique muscle, and is distributed to the corrugator supercilii, orbicularis palpebrarum, and occipito-frontalis muscles, also to the integuments of the forehead and superior eyelid; it communicates with the infra-trochleator branch of the nasal nerve, and sends one or two small filaments into the frontal sinus. The *external* branch, or the *supra-orbital* or *proper frontal nerve*, appears, both in size and in direction, as the continuation of the original trunk; it passes through the superciliary notch or foramen along with the frontal artery, ascends on the forehead, divides into two branches, which subdivide into numerous filaments; these chiefly ascend in the muscles and integuments of the scalp; many of them take a very long course, and communicate with the portio dura, with the occipital nerves, and with those from the opposite side. Both the frontal and lachrymal are nerves of sensation.

The *nasal nerve* separates from the frontal behind the orbit, enters this cavity beneath that branch, and between the two heads of the external rectus; it then runs obliquely forwards and inwards above the optic nerve and below the superior rectus muscle, along with the ophthalmic artery, continues its course along the inner side of the orbit below the superior oblique muscle, and divides into two branches, the external or the infra-trochleator nerve, and the internal or the nasal. The *nasal nerve*, previous to its entrance into the orbit, is joined by a filament from the sympathetic nerve; on the outer side of the optic, and just as it enters this cavity, it gives off a delicate branch about an inch in length, which runs along the outer side of the optic nerve, and forms the long root of the lenticular ganglion; as the nasal nerve passes over the optic it gives off three ciliary nerves. The *infra-trochleator* nerve runs forward beneath the pulley of the oblique muscle, and divides into several filaments, which communicate with the supra-trochleator nerve, and are distributed to the lachrymal passages, and to the integuments and muscles on the side and dorsum of the nose. The *internal* branch, or the *proper nasal*, passes through the anterior of the internal orbital holes into the cranium, crosses the cribriform plate, and descends by the side of the crista galli into

the nasal fossæ, where it divides into posterior and anterior filaments; the former are distributed to the septum, the latter descend behind the nasal bones, and are lost in the integuments at the tip of the nose. The sixth pair of nerves should be next dissected, as it is distributed along with the preceding nerves in the orbit.

Sixth, or Abducens Nerve, after traversing the cavernous sinus (where it is joined by branches from the carotid plexus of the sympathetic nerve), on the outer side of the carotid artery, enters the orbit through the lower part of the foramen lacerum, between the origins of the external rectus, beneath the other orbital nerves, and above and outside the ophthalmic vein; it then passes forwards and outwards, and is distributed to the ocular surface of the external rectus muscle. All the motor nerves in the orbit are distributed to the same surface of their respective muscles, except the fourth, which spreads its branches on the orbital surface of the superior oblique muscle.

The student should next examine the *lenticular* or *ophthalmic ganglion.* This small body is situated near the back part of the orbit, between the optic nerve and the external rectus muscle; it is of a reddish color, and surrounded by soft fat; its posterior superior angle receives the long filament before mentioned from the nasal branch of the ophthalmic, a small filament from the sympathetic accompanies this, and its posterior inferior angle receives the short twig from the inferior oblique branch of the third pair. These two nerves are described by some as the roots of this ganglion, others consider the lenticular or ophthalmic ganglion as one of the cranial ganglia of the sympathetic nerve. I prefer describing it in direct connection with the two principal nerves connected with it, the third and fifth, and which thus become connected in function, while the sympathetic filament is only a branch of communication, as in the case of the spinal ganglia. From the anterior angles of the ganglion two fasciculi of fine nerves proceed, termed the *ciliary;* the inferior fasciculus is larger than the superior. The *ciliary nerves* are about twenty in number: eight or ten in the inferior fasciculus, about six in the superior, and three or four internally, which arise from the nasal nerve. The ciliary nerves twine along the surface of the optic nerve, accompanied by the ciliary arteries, and pierce the back part of the sclerotic coat; they then become flat, and proceed forwards in parallel grooves on the inner surface of that membrane, with very little connection to the choroid coat. At the anterior part of the eye they meet the ciliary ligament; in this substance most of these nerves appear to be lost, but really are not so, as one or two branches may be traced through this into the iris, in which they divide into numerous filaments of extreme minuteness.

The several nerves of the orbit have different offices to discharge. No less than *seven nerves* are engaged in the optic apparatus, viz., the second, third, fourth, sixth, one division of the fifth, the seventh, and the sympathetic. The respective office of each of these is probably as follows: the second is the sentient nerve. for vision; the third, fourth, and sixth supply the orbital muscles with their voluntary or motor power; branches of the seventh also impart the same to the sphincter oculi, or orbicularis palpebrarum; the ophthalmic portion of the fifth endows with sensation all the parts within the orbit, also the interior of the eye, the surface of the globe, the palpebræ, the lachrymal apparatus, the integuments of the forehead, &c. &c. The filaments of the sympathetic nerve serve to connect more closely the component parts of the orbital plexus with each other, and with the system at large; they also probably serve some useful purpose in reference to the ophthalmic ganglion, to which they are connected through the nasal nerve, the sympathetic being directly connected to or engaged in the principal ganglions in the body. The lenticular or ophthalmic ganglion also is interesting as to its connections, as it in this respect resembles the ganglions on the spinal nerves;

thus it has two roots, the third pair supply the motor, while the nasal filament of the fifth, which also carries the sympathetic connection, imparts the sensitive quality. The distribution also of the branches of this ganglion is in accordance with its component elements, inasmuch as they are distributed to one of the most delicately sensible, and to one of the most active structures in the whole range of the animal economy, namely, the iris, the muscular nature of which, too, may be inferred from the very circumstance of this peculiar nervous supply.

The student should next proceed to examine the superior and inferior maxillary nerves, the remaining divisions of the fifth pair. Remove the outer wall of the orbit with the saw or hammer, make a vertical section of the nose and face, and separate the globe of the eye and its muscles from their attachments; below the cavity of the orbit the superior maxillary nerve may be seen.

The Superior Maxillary Nerve is larger than the ophthalmic, passes from the middle of the Casserian ganglion forwards through the foramen rotundum into the pterygo-maxillary fossa; it here sends off several branches, and then, passing through the spheno-maxillary fissure, continues its course forwards along the infra-orbital canal to the face, where it terminates in the infra-orbital nerves. In the pterygo-maxillary fossa it first sends down two small branches along the back part of the superior maxillary bone; these, after a short course, unite in a small triangular, reddish substance, called the *spheno-palatine ganglion*, or the *ganglion of Meckel.* This ganglion is imbedded in fat, surrounded by the branches of the internal maxillary artery, and is situated on the external side of the nasal plate of the palate bone, which separates it from the cavity of the nose, behind the tuberosity of the superior maxillary bone, and in front of the pterygoid processes. Three sets of branches proceed from this ganglion, an inferior, internal, and posterior. First, the *inferior*, or the *palatine nerves*, descend in the bony canal of that name, send some small twigs through this canal to the spongy bones, and near the palate separate into three filaments, an anterior, middle, and posterior; the anterior is the largest, passes forwards in a groove within the alveoli and above the mucous membrane, supplying the latter, and sending small branches to the bone and teeth, and, finally, enters the foramen incisivum by a very fine filament, which communicates with nerves on the septum nasi; the middle and posterior filaments of the palatine nerves are distributed to the amygdalæ, the soft palate, and the uvula; the posterior usually descends through a distinct osseous canal in the pterygoid portion of the palate bone. The *internal* branch, or the *spheno-palatine* nerve, is very short, passes through the spheno-palatine hole into the upper and back part of the nose, and divides into five or six branches; the most of these pass immediately into the mucous membrane, covering the superior and middle spongy bones; one branch, called the *naso-palatine nerve*, or *nerve of Cotunnius*, passes beneath the sphenoidal sinus across the roof of the nose, and descends obliquely forwards along the septum nasi as far as the foramen incisivum, where it communicates with the anterior palatine branches, and where some anatomists describe a small ganglion (*naso-palatine*) to exist; this, however, in the human subject, can seldom be distinguished from the surrounding fat and vessels. The third, or posterior branch of the ganglion, is the *Vidian*, or *superior petrosal nerve.* This passes backwards through the Vidian canal above the internal pterygoid plate, and sends some small filaments into the sphenoidal sinus; it then perforates the cartilaginous substance that closes the foramen lacerum anterius, enters the cranium, and divides into two branches, an inferior and superior; the inferior or carotid branch enters the cavernous sinus, and joins the plexus formed around the artery by the ascending branches of the superior cervical ganglion of the sympathetic: the supe-

rior or petrosal branch runs backwards and outwards beneath the dura mater and Casserian ganglion in a groove on the petrous bone, enters the hiatus Fallopii in this bone, and becomes attached to the portio dura nerve, the point of junction being marked by a small gangliform expansion. The Vidian nerve accompanies the portio dura as far as the back part of the tympanum; it then leaves it, receives the name of *corda tympani*, and enters the tympanum a little below the pyramid; invested by mucous membrane, it now proceeds forwards between the long leg of the incus and the handle of the malleus; to the latter it is firmly connected; it then escapes by a canal which opens near the internal extremity of the glenoid fissure; it next runs downwards, inwards, and forwards, joins the gustatory nerve, and continues attached to it as far as the submaxillary gland; it now leaves the gustatory nerve, and unites with some filaments from it in the *submaxillary ganglion*, which is situated near the posterior edge of the submaxillary gland, and from which a number of filaments proceed; these form a plexus which supplies this gland. As this Vidian or recurrent nerve takes this singularly intricate course, it goes under different names in different situations, and it serves to maintain several interesting communications; for example, it connects the cervical ganglions of the sympathetic nerve with the spheno-palatine, also the latter with the submaxillary ganglion; it also joins the superior and inferior maxillary nerves to one another, and both to the portio dura; the nervous supply to the muscles of the palate also is thus connected to the portio dura, the great muscular nerve of the face, &c. Some anatomists deny the continuity of the Vidian and corda tympani nerves, and consider them as distinct, the Vidian as a connecting branch between the spheno-palatine of Meckel's ganglion and the portio dura, and the corda tympani as a branch of the latter, arising lower down than the end of the Vidian, then proceeding across the tympanum, and, finally, joining the gustatory nerve and the submaxillary ganglion.

The superior maxillary nerve, immediately after, and sometimes previous to giving off the two descending branches which join the spheno-palatine ganglion, sends off the *orbital branch;* this ascends through the spheno-maxillary fissure, and divides into two branches, the malar and temporal. The *malar* communicates with the lachrymal nerve, passes through a small canal in the malar bone, and is distributed to the integuments and muscles covering the malar bone; the *temporal* branch also passes through the malar bone into the temporal fossa, pierces the temporal fascia, becomes cutaneous, and, joining some branches of the facial nerve, it accompanies the temporal artery, and is lost in the integuments on the side of the head. The superior maxillary nerve next gives off the *posterior dental nerves;* these are two or three branches, which wind round the tuberosity of the maxillary bone, enter small foramina, which lead to the posterior alveoli in this bone, and supply the molar teeth; some branches also supply the gums and the buccinator muscle. As the *infra-orbital nerve*, which is the last branch of the superior maxillary, proceeds along the floor of the orbit, it sends off some small filaments to the fat and muscles in this region, also the *anterior-dental;* this nerve descends in an osseous canal along the forepart of the antrum, to the lining membrane of which it gives some fine filaments, and is then lost in several branches which supply the canine and incisor teeth: the infra-orbital nerve then escapes through the foramen of the same name, beneath the orbicularis palpebrarum and levator labi superioris alæque nasi muscles. It here divides into several branches, which are distributed to the face; some of these ascend to the palpebræ, others pass outwards to the cheek, and the largest branches descend to the ala nasi and to the upper lip; these different branches have frequent communications on the side of the face with the portio dura, on the nose with the nasal nerves, and on the buccinator muscle they form a plexus with each other and with the buccal and facial nerves.

The Inferior Maxillary Nerve.—This, which is the third and largest branch of the fifth pair, immediately descends from the ganglion, through the foramen ovale, into the zygomatic fossa, behind the external pterygoid muscle, where it divides into two large branches, a superior or external, and an inferior or internal. The inferior maxillary nerve consists of two portions, one is plexiform and sensitive, and proceeds from the Casserian ganglion; the other is concealed by this, and consists of white parallel fibres, which do not pass through the ganglion; this is the motor portion of this nerve. In the zygomatic fossa this small, deep portion winds round the other, becomes anterior to it, and both unite inseparably; the nerve then divides into two branches, superior and inferior. The *superior* or *external* retains the motor portion of the trunk, and immediately subdivides into five branches, viz., the two deep temporal, masseteric, buccal, and pterygoid. The *inferior* or *internal* division of the nerve is the larger, and subdivides into the auricular, inferior dental, and gustatory nerves, which are probably all nerves of sensation. First, the *deep temporal nerves* are two in number, an anterior and posterior; they ascend between the temporal bone and muscle, and are lost in the latter; some small branches escape through the temporal fascia, and communicate with the cutaneous temporal nerves. Second, the *buccal nerve* arises in general in common with one of the last; it passes forwards and downwards between the pterygoid muscles, to the external of which and to the temporal it sends some branches; it then passes between the coronoid process and the buccinator muscle, and on the latter it divides into several long branches, which form a plexus on this muscle with branches of the facial and infra-orbital nerves. Third, the *masseteric* branch descends obliquely backwards and outwards through the sigmoid notch of the inferior maxilla, between the temporal muscle and the neck of the lower jaw, close to the latter, to the articulation of which it also sends some filaments; it is lost in the substance of the masseter muscle. Fourth, the *pterygoid nerves* are two or three delicate branches, which descend to the pterygoid muscles. Thus the motor portion of the trunk of the inferior maxillary nerve can be traced into those muscular branches which supply the five great muscles of mastication.

The inferior division of this nerve divides into three branches, viz., the auricular, dental, and lingual or gustatory nerves. First, the *auricular* or *temporo-auricular* branch arises by two or three roots, between which the arteria spinosa ascends. This nerve passes backwards and outwards behind the neck of the lower jaw, and before the meatus auditorius; it here communicates with the facial nerve, and sends small filaments to the meatus and to the cartilages of the ear, also to the articulation of the lower jaw; it then divides into several branches; some ascend through the parotid gland over the zygoma, follow the divisions of the temporal artery, and communicate with the facial nerve, and are lost in the integuments on the anterior and lateral parts of the head; others descend in the gland, send small filaments into the tympanum, and communicate with the facial, dental, and ascending branches from the cervical plexus. Second, the *inferior dental nerve* separates from the gustatory, and is again connected to it by a small twig; it then descends external to it, at first between the two pterygoid muscles, then between the lower jaw and the internal pterygoid; it is here separated from the latter by the internal lateral ligament; about the middle of the internal surface of the ramus of the jaw it sends off a small filament, the *mylo-hyoid nerve;* this descends obliquely forwards, confined in a groove in the bone by an expansion from the internal lateral ligament; near the chin it divides into small branches for the mylo-hyoid, genio-hyoid, and digastric muscles, the adjacent cellular tissue, and lymphatic glands. The dental nerve then enters the canal in the lower jaw, which extends from the dental foramen obliquely forwards beneath the teeth as far as the chin. In this course this nerve, which is ac-

companied by the dental vessels, supplies each of the molar and canine teeth with soft, delicate twigs; and at the mental foramen it divides into two branches, one continues its course within the bone beneath the incisor teeth, the other is the *mental nerve;* this escapes by the mental foramen, bends upwards, and divides in a radiated manner into several branches, which pass to the muscles, mucous membrane, and integuments of the lower lip, and communicate with the facial nerve. Third, the *lingual* or *gustatory nerve* is smaller than the dental, to which it is connected by a short branch which incloses a space through which the internal maxillary artery passes. Beyond this branch of communication the corda tympani (which has been before traced from Meckel's ganglion) joins the gustatory nerve at an acute angle; the latter is increased in size at this spot. The gustatory nerve is here situated between the external pterygoid and the muscles of the palate and pharynx; it then descends obliquely forwards between the internal pterygoid and the ramus of the lower jaw; it next turns forwards above the sub-maxillary gland and the mylo-hyoid muscle, and lies on the mylo-hyoidean attachment of the superior constrictor of the pharynx and on the mucous membrane of the mouth and the stylo-glossus muscle, and accompanies the Whartonian duct; it then ascends above the sublingual gland, and becomes attached to the lateral and anterior parts of the tongue. In this arched course the gustatory nerve gives off, first, one or two small filaments to the internal pterygoid muscle; second, several to the tonsils, to the muscles of the palate, to the upper part of the pharynx, and to the mucous membrane of the gums; third, the corda tympani, and some accompanying filaments to form a plexus which supplies the sub-maxillary gland; fourth, a few branches which descend along the hyo-glossus muscle to communicate with the ninth or the lingual nerve; fifth, a fasciculus of nerves to the sublingual gland, and to the surrounding mucous membrane; lastly, at the tongue it divides into several branches, some pass deep into the tissue of this organ, others, long, fine, and soft, rise towards its surface, and are lost in the mucous membrane and in the small conical papillæ near its tip.

In addition to the four ganglions already described in connection with the fifth pair of nerves, namely, the Casserian ganglion with the trunk of the nerve, the lenticular or orbital ganglion with its first division of the ophthalmic nerve, the spheno-palatine or Meckel's ganglion, with its second division or superior maxillary nerve, and the sub-maxillary ganglion, with its third division or inferior maxillary nerve, another in connection with the last-mentioned nerve has of late years been described by Arnold under the name of Otic Ganglion. This body, small and indistinct, is situated immediately below the foramen ovale, on the inner side of the inferior maxillary nerve, external to the Eustachian tube and tensor palati muscle, and in front of the middle artery of the dura mater; it is connected by very short filaments to the maxillary nerve and to its pterygoid and auricular branches, the latter being a sentient, the former a motor nerve; it is also connected to the soft branches of the sympathetic nerve which accompany the spinous artery; it gives off, first, a small filament to the tensor palati muscle; second, a larger one to the tensor tympani muscle, lodged in the canal in the petrous bone above the Eustachian tube; and, third, the small, superficial, petrosal nerve. This enters the cranium through a small canal between the petrous bone and spinous process of the sphenoid, passes backwards on the surface of the former, enters a minute foramen in front of the hiatus Fallopii, and divides into two filaments; one joins the ganglionic expansion at the junction of the large petrosal or Vidian nerve with the portio dura, the other enters the tympanum, and joins the tympanic branch of the glosso-pharyngeal in the tympanic plexus. This latter branch Arnold describes as one of the origins of the otic ganglion, and compares it to the long sentient root in the ophthalmic

ganglion derived from the nasal nerve, while the short motor root unites it to the inferior maxillary nerve. It requires much time and care to expose the nervous filaments just mentioned; a vertical section of the fœtal head is best suited for the dissection; the inferior maxillary nerve should be exposed as it is passing through the foramen ovale, and as the motor is joining the sentient portion; the dissection should be made on the inner or pharyngeal side of the nerve; connected to it, in this situation, will be found a quantity of reddish, fibro-cellular tissue, traversed by the fine nervous filaments above-mentioned; but, as far as my observation extends, a distinct ganglion is by no means so evident as is represented by Arnold and the other writers who have followed his description. The same remark will apply to the spheno-palatine and to the sub-maxillary ganglions; but the lenticular or ophthalmic ganglion is always to be found, though variable as to size and color, in some being pale and flat, in others red and round, like a small berry.

The SIXTH PAIR of nerves have been described at page 436.

VI. FACIAL NERVE, or PORTIO DURA of the seventh pair. This nerve first traverses the meatus auditorius internus in a direction outwards; on the inner wall of the tympanum, and between the vestibule and cochlea; it then enters the semicircular canal, named aqueduct of Fallopius. This canal leads from the meatus at first in a horizontal direction backwards, then outwards, above the fenestra ovalis and at the back part of the tympanum; it then descends vertically to the stylo-mastoid foramen on the lower surface of the petrous bone; the nerve then bends forwards into the parotid gland, and, after a course of about half an inch in length, divides behind the ramus of the jaw into its two terminal branches, the temporo-facial and cervico-facial. In the meatus internus the portio dura, or facial, lies above the portio mollis, or auditory nerve, in a groove in the latter, a small artery intervening. If the upper part of the meatus be removed with the bone forceps, the early course of the nerve is exposed; in raising it out of this groove fine filaments are seen connecting it to the portio mollis. These are considered by most anatomists as communicating nervous filaments. I have some doubts, however, whether these connecting fibres are really nerves, or only fine vessels and areolar tissue; if nerves, they present the singular peculiarity of union between a nerve of motion and one of special sense. Opposite the hiatus Fallopii the portio dura is joined by the great petrosal or Vidian nerve from Meckel's ganglion, and by the lesser petrosal nerve from the otic ganglion, also by a small filament from the sympathetic nerve, which accompanies the spinous artery, and is named the external petrosal nerve. At the junction of these three branches with the portio dura, a flattened ganglionic expansion is observed, in which the exact arrangement, and from which the further course of these small connecting filaments, are differently described by different anatomists. Some affirm that in this ganglion they are all blended together, and cannot afterwards be distinguished from the portio dura; others maintain that the large petrosal or Vidian nerve can be separated from the portio dura, though connected to it in a plexiform manner, and can be traced into that remarkable branch called the corda tympani, which is afterwars connected in a similar plexiform manner to the gustatory nerve. From my own dissections of these nerves, I am induced to adopt the latter opinion. This remarkable union at the back of the hiatus Fallopii must serve to maintain free communication between the facial or motor nerve and the fifth or the sentient nerve, analogous to those more obvious communications seen upon the face between the terminating filaments of these nerves. This connection, also, so close to the tympanum, which contains the ossicula and musculi auditus, may be designed to impart the twofold properties of sensation and of motion to this apparatus, through the filaments which connect the portio dura subsequently to the tympanic plexus: thus the organ of hearing, like that of vision, will be furnished

with the three sets of nerves, one for special sense, one for sensation, and one for motion. In its course along the aqueduct of Fallopius it sends a small branch, the *tympanic*, into the tympanum, close to the neck of the stapes; and lower down it gives off the *corda tympani;* this first ascends in a bony canal on the back of the tympanum parallel to the aqueduct; it then enters the tympanum through a foramen between the pyramid and the osseous border of the membrana tympani, and crosses the tympanum obliquely downwards and forwards, invested by mucous membrane, and placed between the handle of the malleus and the long leg of the incus, and then escapes at the anterior inferior angle of this chamber through a small distinct foramen on the inner side of the Glasserian fissure; proceeding downwards and inwards it increases in size, probably only from receiving a stronger sheath, and soon joins the gustatory nerve between the pterygoid muscles; in this nerve it appears intimately connected with its general fibres; it is by dissection alone that the connection can be unravelled, and then it will be seen to present a plexiform appearance through its whole course, at one time receiving filaments from the gustatory, at another giving them off, so that it is not a separate or independent filament throughout this course; below the angle of the jaw it separates from the trunk of the gustatory, and, accompanied by some filaments from the latter, enters the sub-maxillary ganglion. Near the origin of the corda tympani the portio dura is joined by one or two filaments from the auricular branch of the pneumogastric nerve, and still lower down by one from the glosso-pharyngeal. As it escapes through the stylo-mastoid foramen it gives off three branches, the posterior auricular, stylo-hyoid, and sub-mastoid or digastric; the first, or the *posterior auricular*, bends upwards and backwards behind the cartilage of the ear, to which it sends several long branches; others also pass backwards to the integuments covering the mastoid process and the occipital bone; the second, or the *stylo-hyoid* nerve is distributed to the digastric and styloid muscles, and anastomoses with the sympathetic and glosso-pharyngeal nerves; the third, or the *sub-mastoid* or *digastric branch*, perforates the posterior belly of the digastric, supplies it with several filaments, and then communicates with the glosso-pharyngeal nerve around the jugular vein, close to the base of the cranium; other filaments descend, and join the laryngeal branches of the pneumogastric nerve. The facial nerve then turns forwards over the external carotid artery and external jugular vein, but sometimes between these, and through the parotid gland; in this substance it divides into two large branches, the superior or larger is called the temporo-facial; the inferior, which is smaller, the cervico-facial: these two branches take different directions, but are still connected together by cross branches, which form loops and interlace with each other in a plexiform manner; this plexus is named *parotidean plexus* or *pes anserinus*. The *temporo-facial nerve* ascends obliquely forwards across the neck of the lower jaw; it first communicates with the auricular branch of the inferior maxillary nerve, and then divides into three fasciculi, the temporal, malar, and buccal. These nerves take that course which their names imply; they are all remarkable for the plexiform arrangement of their branches, and for their frequent communications with each other, and with the three divisions of the fifth pair, which are distributed to the face. The *cervico-facial nerve* descends obliquely forwards through the parotid gland towards the angle of the jaw, where it is only covered by the skin and platysma. This nerve also divides into many branches, which may be arranged in three fasciculi, the maxillary, the sub-maxillary, and the cervical; the first, or the *maxillary*, cross the ramus of the jaw and the masseter muscle, and communicate in the muscles of the lower lip with the mental nerve, and with the superior division of the seventh; the second, or *sub-maxillary*, course along the base of the jaw, sending filaments to the integuments and superficial muscles; these also communicate at the chin with the mental

nerve; the third, or *cervical* branches, are very long and numerous, they are distributed to the platysma and to the superficial muscles of the neck, and communicate with several filaments of the cervical plexus. The portio dura nerve has been ingeniously supposed by Mr. Bell to be the nerve designed to excite the muscles of the face in particular conditions of respiration and in the expression of passion, &c.; hence he has named it the respiratory nerve of the face. Others, more correctly, consider it as the exclusive motor nerve of all the superficial muscles of the face, of the eyelids, nose, mouth, lips, ear, also of the cutaneous muscles of the neck; it communicates with the three divisions of the fifth, with the glosso-pharyngeal and par vagum, and with the cervical spinal nerves.

VII. The Auditory Nerve, or Portio Mollis of the seventh pair. This, which is a simple nerve of sense, separates from the portio dura at the bottom of the meatus auditorius internus, and then divides into two branches, an anterior and posterior; the anterior passes forwards to the cochlea, penetrates through many small openings, and is distributed to the membrane covering its spiral laminæ, and to that lining the canal in its axis: the posterior branch passes outwards, forms a gray swelling, from which proceed several filaments to supply the membrane lining the vestibule and semicircular canals. (*See* Anatomy of the Ear.)

VIII. Glosso-pharyngeal Nerve, the first and highest branch of the eighth pair. This small nerve passes through the foramen lacerum posterius by a distinct fibrous canal, anterior and internal to the vein, and to the other divisions of the eighth pair of nerves; it then descends between the jugular vein and internal carotid artery, passes forwards in front of the latter and behind the styloid process and muscles, but soon winds round the stylo-pharyngeus to its forepart, and descends obliquely inwards between it and the stylo and hyo-glossus to the posterior and lateral parts of the tongue. In this course this nerve forms an arch nearly parallel to those which the gustatory and lingual nerves describe; it is smaller than either of these nerves, is situated between them, but deeper than either, and has very little, if any, communication with them; it is superior to the laryngeal nerve, and ends in branches to the pharynx, to the tongue, and to the tonsil. As this nerve is passing through the jugular canal and foramen it presents two ganglions, one (the jugular ganglion) at the upper part of the canal, small, and only involving a portion of the nerve; the other (the petrous or ganglion of Andersh) is lower down, and much larger, and is lodged in a depression in the petrous bone; from this arise its principal communicating branches, to join the sympathetic, the facial, and the pneumogastric; also its *tympanic filament*, or *nerve of Jacobson.* This nerve arises from the inferior ganglion, ascends into the tympanum through a small canal in the ridge of bone between the jugular and carotid foramina; it divides into numerous branches, some join with filaments from the fifth, the facial, and sympathetic nerves, and form with these the tympanic plexus; other filaments pass along the bony canals in the walls of the tympanum in different directions, and unite some with the sympathetic in the carotid canal, others with the large petrosal nerve in the hiatus Fallopii, and another either joins the lesser petrosal nerve from the otic ganglion, or may be considered as this nerve itself. In the neck this nerve next gives off some branches to the lateral and posterior parts of the pharynx; these, together with branches from the pneumogastric and the sympathetic, form the pharyngeal plexus; others descend still lower in the neck, and unite with the sympathetic and cardiac nerves; others ascend to the amygdala, and assist in forming the tonsillitic plexus. As it approaches the pharynx it gives several branches to the stylo-pharyngeus and hyo-glossus muscles, also to the superior and middle constrictors of the pharynx; several filaments pass between these to the mucous membrane of the pharynx and

fauces, also to the folds or arches of the palate and to the epiglottis: the remaining branches of the glosso-pharyngeal nerve are distributed partly to the muscular substance, but principally to the large papillæ and mucous membrane at the root of the tongue. The function or office of this nerve has given rise to much difference of opinion; the lingual branches have been by some considered sentient, and the muscular or pharyngeal both sentient and motor: but the observations and experiments of Dr. T. Reid (see Encyclopædia of Anatomy, art. Glosso-Pharyngeal Nerves) lead to the conclusion that it is one of common sensation, and essentially an afferent nerve, conveying the impressions made on the mucous surface to the medulla oblongata, which there excite the reflex motor powers in other nerves and in the muscles of the fauces and pharynx.

Pneumogastric Nerve, or nervus vagus. This large compound nerve passes through the foramen lacerum in a fibrous canal in common with the spinal accessory, but distinct from the last-described nerve, and anterior to the jugular vein. In the foramen it presents a ganglionic expansion, and below it a gangliform swelling near an inch in length; the latter communicates beneath the base of the cranium, and in front of the two first cervical vertebræ, with the facial, glosso-pharyngeal, spinal accessory, sympathetic, and superior spinal nerves; all these form an intricate plexus, which may be named "basilar plexus." The nerve here has the compact appearance, and sometimes the grayish tint, of a ganglion; at first it is placed anterior to the vein and to the lingual nerve; it soon, however, passes behind both, and opposite the atlas the vein separates it from the glosso-pharyngeal nerve which lies anterior to that vessel; the vagus then descends along the forepart of the neck, inclosed in the sheath of the carotid artery and jugular vein, between these vessels, but rather behind them, and more closely connected to the vein; on the right side it enters the thorax between the subclavian vein and artery, crossing the latter at right angles; on the left side it is also anterior, but nearly parallel to the subclavian artery, a little below which it crosses obliquely the back part of the arch of the aorta. In the thorax these nerves descend at first obliquely backwards behind the roots of the lungs, and enter the posterior mediastinum; they then descend along the œsophagus through the diaphragm, and end on the stomach. The branches of each may be divided into cervical, thoracic, and abdominal. The cervical branches are the communicating, the auricular, the pharyngeal, the superior laryngeal, the cardiac, and the recurrent or inferior laryngeal. Its superior ganglion, in the jugular foramen, communicates with the glosso-pharyngeal nerve, and the inferior ganglion gives off the *auricular:* this ascends in a small canal in the petrous bone external to the jugular and internal to the stylo-mastoid foramen, enters the aqueduct of Fallopius, crosses and is connected to the facial nerve, and then, escaping from the bone between the external meatus and the mastoid process, is distributed to the integuments and to the cartilage of the ear. The inferior ganglion communicates with the several nerves before mentioned in the basilar plexus. The *pharyngeal nerve*, or nerves, arises from the vagus near the base of the cranium, and soon receives a twig from the spinal accessory; it descends obliquely inwards, behind the carotid artery, to the side of the pharynx, divides into several branches, which communicate with those from the glosso-pharyngeal, superior laryngeal, and sympathetic; all these branches form the *pharyngeal plexus*. This plexus extends along the side of the middle and upper constrictors, and sends numerous filaments to each of these muscles, and to the mucous membrane of the pharynx and fauces. The *superior laryngeal nerve* arises from the ganglion a little below the last; it runs in an arched manner downwards and forwards behind the internal carotid artery, and below the superior cervical ganglion, with which it communicates, as also with the lingual nerve; it sends several filaments to

the pharyngeal plexus, and then divides into two branches, external and internal; the external and smaller is distributed to the sterno-hyo and crico-thyroid, and to the other superficial muscles, also to the thyroid body and to the cartilages of the larynx, and communicates with the sympathetic and recurrent nerves. The internal, accompanied by a small artery, perforates the thyro-hyoid membrane, and divides into numerous branches; many of these go to the anterior surface of the epiglottis, to the glands and mucous membrane connected with it, to the arytenoid glands and muscles, and communicate with the recurrent or inferior laryngeal, beneath the ala of the thyroid cartilage; occasionally a long filament descends obliquely forwards along the side of the larynx, beneath the thyroid cartilage, to supply the crico-thyroid muscle, in case the external laryngeal branch has not done so. This internal branch of the laryngeal nerve is chiefly distributed to the mucous membrane of the glottis and larynx, and is essentially the sensitive nerve to this very region. As the vagus descends it gives off fine filaments to the carotid artery, some of which unite with the sympathetic and with the cervical nerves. A little above the arteria innominata the right vagus gives off *cardiac branches* two or three in number; these cross the carotid either before or behind it, and join the cardiac nerves from the sympathetic. The nerve of the left side does not send off so many or such large cardiac branches as that on the right side; on the left they accompany the carotid artery to the arch of the aorta, expand over it, and join the cardiac plexus. The *inferior laryngeal nerve*, or *recurrent;* that on the *right side* curves round the subclavian artery, ascends obliquely inwards, behind the carotid and inferior thyroid artery, along the side of the trachea to the larynx. At its origin it gives off some cardiac filaments, afterwards some branches to the forepart of the trachea and the thyroid gland; it then supplies the lower part of the pharynx, and ends in the posterior and lateral crico-arytenoid and in the thyro-arytenoid muscles, also in the mucous membrane of the larynx, on which it communicates with the superior laryngeal nerve. The *recurrent nerve on the left side* is longer, as it curves round the arch of the aorta behind the ligamentous remains of the ductus arteriosus; it gives off several cardiac and pulmonary branches, and then ascends along the œsophagus, and terminates in a similar manner to that on the right side. The recurrent nerves are the proper motor nerves of the larynx, and supply all its muscles except the crico-thyroid.

The pneumogastric nerves in their course through the thorax, pass behind the roots of the lungs, close to the bronchi, where they present an open, plexiform appearance, and send off the pulmonary and œsophageal nerves. The *pulmonary branches* arise from each vagus a little above the roots of each lung; a few of these branches pass to the forepart of the bronchial tubes, and form there a small plexus, termed the *anterior pulmonary plexus*. This plexus communicates with the phrenic and cardiac nerves, and sends its fine filaments along the pulmonary vessels to the lungs and pericardium: the greater number of these pulmonic branches pass behind the bronchial tubes to the posterior pulmonic plexus. Near the root of the lung each vagus increases in size, its fibres divide, subdivide, and reunite in an areolar or plexiform manner, forming the *posterior pulmonic plexus*. This plexus is very large, lymphatic glands and vessels are entangled in it, and several branches from the sympathetic join it; its numerous filaments accompany the bronchial tubes closely through the substance of the lungs. Below the root of each lung the fibres of each vagus again approximate, and these nerves now become attached to the œsophagus, along which they descend to the stomach, the left on its anterior, the right (which entered the chest on a plane anterior to the left) on its posterior surface: they frequently communicate with each other, so as to encircle the œsophagus with a sort of plexus, which is named the *œsophageal plexus*, or *plexus gulæ*. On the stomach, the right vagus,

which is the largest, passes behind the cardiac orifice, to which it sends several small branches, which unite with some from the left or anterior nerve; these form the cardiac plexus which encircles this part of the stomach. It then sends many long filaments to the muscular and mucous coats of the stomach; these communicate very freely with the solar plexus, also with the splenic, hepatic, and renal. The left or anterior vagus spreads its branches along the anterior surface of the stomach and the lesser curvature; several of these pass along the lesser omentum to the liver and gall bladder. The pneumogastric nerves supply the pharynx, œsophagus, and partly the stomach, also the larynx, trachea, lungs, and partly the heart; they are, therefore, concerned in deglutition, voice, respiration, circulation, and digestion, and maintain important sympathies between the different organs concerned in these functions.

The Nervus Accessorius, or spinal accessory, is the third branch of the eighth pair. This nerve, in passing through the foramen lacerum, is closely connected to the vagus by one or two filaments. Below the base of the cranium it communicates with the ninth and sympathetic nerves, and divides into two branches, the internal and smaller of which joins the ganglion of the vagus near the origin of the pharyngeal nerve: the external branch passes outwards behind the internal jugular vein, but sometimes before it, perforates the upper third of the sterno-mastoid muscle, to which it sends some filaments; it then communicates freely with the cervical plexus, is increased in size, and supplies the trapezius, even to the scapula, &c. This is supposed to be a compound nerve, but essentially motor, and has been named by Bell "the respiratory nerve of the neck." When this and the vagus are considered in conjunction, they may be compared to a compound spinal nerve, the vagus with its ganglion being the sensitive, and the accessory the motor root; their connection, however, may render the branches of each compound in function.

IX. The Lingual Nerve, or the ninth, is a simple motor nerve. On escaping from the anterior condyloid foramen it communicates with the eighth, the sympathetic, and the nervous arch or loop of the atlas; it is at first posterior to the vessels and nerves in this situation; it then descends between the vein and artery, soon turns forwards, and becomes superficial to them, as well as to the external carotid; it takes the arched course of the digastric muscle across the neck, hooking round the occipital artery, parallel but superficial to the lingual, and, arriving at the side of the base of the tongue above the os hyoides, it passes above the mylo-hyoid muscle, and lies on the middle constrictor and on the hyo-glossus, at the anterior edge of which it divides into several filaments; some of these plunge into the lingualis and genio-glossus muscles, others continue on to the point of the tongue, communicating with each other, and supplying the muscular substance of this organ. As the lingual nerve is bending across the neck, below the digastric tendon and around the occipital artery, it sends of a considerable branch, the *descendens colli* or *noni*. This nerve frequently receives a filament from the pneumogastric; it descends along the forepart of the sheath of the carotid artery; about the middle of the neck it is joined by the internal descending branches of the cervical plexus, with which it forms a small triangular plexus, the branches of which pass to the omo and sterno-hyoid and thyroid muscles; on the latter some filaments descend into the chest. Near the os hyoides the lingual nerve sends some filaments to the constrictors of the pharynx and to the stylo-pharyngeus, also a superficial branch to the thyro-hyoid muscle. On the surface of the hyo-glossus it gives off several branches to the surrounding muscles, some also to communicate and form a plexus with the gustatory branch of the fifth pair; the lingual nerve then terminates chiefly in the genio-hyo-glossus muscle, and in the general muscular structure of the tongue, which organ it supplies with motor power.

SECTION II.

DISSECTION OF THE SPINAL NERVES.

There are eight cervical nerves, which increase in size as they descend; the first passes out above the atlas, and is named the sub-occipital; the eighth passes out above the first dorsal vertebra. All these nerves, except the first and second, immediately outside the intervertebral foramina, divide into a posterior and an anterior branch; the posterior of each is smaller than the anterior, with the exception of the two first; the divisions of the first are nearly equal, but the posterior branch of the second is much larger, as it not only supplies the adjacent muscles, but also accompanies the occipital artery and its ramifications in the scalp. The posterior branches of the other cervical nerves are small, they all communicate with each other, and are distributed to the integuments and muscles on the back part of the neck; the anterior branches of the four first form the cervical plexus, and those of the four last the brachial plexus. The anterior branch of the first, or the *sub-occipital*, passes forwards above the transverse process of the atlas, in a groove beneath the vertebral artery; it supplies the adjoining small recti muscles, then descends before the atlas, and unites with the anterior division of the second cervical, so as to encircle the transverse process of that bone with a *nervous loop*. In this course the sub-occipital is united by branches to the eighth and ninth, and to the superior ganglion of the sympathetic nerve; with the latter nerve the anterior branches of all the spinal nerves regularly communicate.

The *second cervical nerve*, like the first, divides within the canal into its anterior and posterior branch. The *anterior branch*, at first between the arches or laminæ of the atlas and dentatus, passes forwards between their transverse processes, and on the outer side of the vertebral artery; it there gives off filaments to the adjacent muscles, and soon divides into an ascending and descending branch; the former joins the descending loop from the first, and the latter unites with the ascending branch from the third, and both are connected to the superior cervical ganglion of the sympathetic. The *anterior division of the third* is much larger than that of the second, but, like it, divides into an ascending and descending branch, which unite with the second and the fourth. The *fourth* divides in like manner; its descending branch is joined by a small filament to the fifth, and then divides into several branches, which pass downwards and outwards towards the clavicle and acromion, and between the sterno-mastoid and trapezius muscles. The anastomoses, between the anterior branches of the four superior cervical nerves, constitute the cervical plexus. The anterior branches of the four inferior cervical are much larger than those of the superior; they are united in a somewhat similar manner to each other, and to the anterior branch of the first dorsal, and constitute the brachial plexus. These two plexuses and their branches the student may next dissect.

The Cervical Plexus is formed by the loops and communications between the anterior branches of the four superior cervical nerves, which join each other in arches, from the convexities of which branches arise that again join in a similar manner; lymphatic glands and a quantity of cellular tissue are entangled in the areolæ between these. This plexus, or rather series of plexuses, is situated on the side of the neck, on a level with the second, third, and fourth vertebræ, between the sterno-mastoid and trapezius muscles; is partly covered by the former and by the platysma and fascia; it rests upon the vertebral attachments of the levator anguli scapulæ and splenius muscle, and is external to those of the rectus anticus major and to the internal jugular vein. This plexus communicates with the superior cervical ganglion of the sympa-

thetic above, and with the continued cord of this nerve lower down, also with the pneumogastric and lingual nerves, and with the spinal accessory; the latter may be said to assist in forming it beneath the sterno-mastoid muscle. In addition to numerous communicating and muscular filaments it sends off several long branches, which may be classed into ascending and descending; the former are superficial, the latter are both superficial and deep. The ascending superficial branches are two or three in number, viz., superficial, cervical, auricular, and occipital. The first, or *superficialis colli*, is often double; it arises about the middle of the neck, and principally from the second and third cervical nerves, bends round the posterior border of the mastoid muscle, ascends obliquely forwards along with the external jugular vein, and divides into several fine, long filaments, some of which descend in the integuments on the antero lateral regions of the neck, but the most of them ascend towards the angle of the jaw, and form cutaneous plexuses with the cervico-facial nerves. The second branch, or the *auricularis magnus*, is larger than the last, arises in the same situation, and ascends nearly parallel, but posterior to it. At the parotid gland it divides into an anterior superficial and cutaneous branch, and a posterior larger and deeper, which passes through the lower part of the gland, crosses the mastoid process, and is distributed to the external ear, and to the side and back part of the scalp. The filaments of this nerve communicate with those of the facial, not only in the integuments and fascia, but also in the substance of the parotid gland. The third branch, or *occipitalis minor*, arises near the last, from the second cervical nerve; it ascends parallel to the posterior border of the mastoid muscle to the scalp, and is distributed to the skin and to the occipito-frontalis muscle, and communicates with the great occipital and auricular nerves.

The descending branches are superficial and deep; the superficial descending branches, or *supra-clavicular*, are long and rather large; they are uncertain in number, and in exact situation, they arise from the third and fourth cervical nerves, and descend between the trapezius and mastoid muscles, and supply these in their course; they become larger near the clavicle, over which they pass. The internal and middle branches ramify in the cellular tissue and integuments over the pectoral and deltoid muscles, and the external branches over the acromion and the clavicular attachment of the trapezius.

The deep descending branches are the muscular, the communicating, and the phrenic. The *muscular branches* arise from different parts of the plexus, and are principally distributed to the trapezius, levator anguli scapulæ, and sterno-mastoid muscle; small and deep-seated branches also supply the scaleni and the deep anterior spinal muscles. The *communicating branches* are very numerous; each cervical nerve is connected, as already stated, to the sympathetic. The branches of the spinal accessory are entangled among those of the plexus; some join its loops between and beneath the mastoid and trapezius muscles, and others unite in a plexiform manner with the nerves that supply these. From the second and third roots of the plexus descends the *communicans noni*. This, which is very regular, is often double, and arises by two or three roots, which unite and form a long and delicate nerve that descends obliquely inwards and forwards, generally in front of the sheath of the cervical vessels, though sometimes behind the jugular vein, and unites with the descendens noni or colli nerve, opposite the thyroid body, and near the middle tendon of the omo-hyoid muscle. A small plexus, or open network, exists at the junction, and from this, branches proceed to the posterior portion of the omo-hyoid and to the inferior portions of the sterno-hyoid and thyroid muscles. The last and most important branch of the cervical plexus is the *internal respiratory* or *phrenic nerve*. This arises from the lower part of the plexus, chiefly from the third and fourth cervical; it has also in general a filament or two from the fifth, or from the brachial plexus, and from

the sympathetic. The phrenic nerve descends obliquely inwards on the anterior scalenus muscle, and at the lower part of the neck communicates with the lower cervical ganglion, and often with the vagus or its recurrent; it then enters the thorax between the subclavian vein and artery, and descends in the middle mediastinum to the diaphragm on the side of the pericardium, between it and the pleura, accompanied by a small artery from the internal mammary: the right phrenic is nearly perpendicular, the left takes an oblique course round the apex of the heart; it is, therefore, longer, and lies more posterior than the right. On the diaphragm these nerves divide into several branches, some of which ramify on the superior surface of that muscle, others on its inferior; the latter accompany the phrenic vessels. The terminating branches on the right side send some filaments to the inferior vena cava and to the liver, and unite with the nerves of this organ; on the left side some very fine filaments pass towards the œsophagus and stomach; these, probably, communicate with the vagus and solar plexus.

Next examine the posterior branches of the cervical nerves.

The *posterior division of the sub-occipital* is as large as the anterior, passes out of the spinal canal, above the arch of the atlas, along with and posterior to the vertebral artery, enters the triangular region beneath the occipital bone, bounded by the recti and obliqui muscles; it then divides into several small branches, which are enveloped in the adipose substance which abounds in this situation; these branches are distributed to the greater and lesser recti and obliqui muscles, also to the complexus. A small cutaneous branch has been observed, and a filament descends either through or around the inferior oblique to join the second cervical nerve.

The *posterior branch of the second* is the largest of the entire series of the spinal nerves; it passes backwards and outwards between the laminæ of the axis and dentatus, and beneath the inferior oblique muscle, where it communicates with the sub-occipital nerve, and soon afterwards with the third cervical. It then gives off filaments to the adjacent muscles, viz., the complexus, splenius, trachelo-mastoideus, and obliquus inferior. The continued trunk, named the *occipitalis major,* ascends over the inferior oblique, pierces the complexus, and shortly afterwards the trapezius, and then becomes sub-cutaneous; is broad and flat, accompanies the occipital artery in the scalp, between the skin and occipito-frontalis, divides into numerous long filaments, which can easily be followed as far as the vertex; some pass laterally to the ear, and communicate with the auricular nerves.

The *posterior branch of the third* is much smaller than the last, and that of the fourth is smaller than the third; they both communicate with each other, also with the second, and through that with the first. This series of communication between these four nerves, beneath the complexus muscle, has been named by Cruveilhier and others the "posterior cervical plexus." The branches from this plexus principally pass inwards towards the spinous processes, some supply the different laminæ of muscles, others pierce the complexus and trapezius, and become cutaneous; one branch from the third cervical nerve ascends to the lower part of the occipital region, internal to the great occipital nerve, and is distributed to the scalp.

The *posterior branches of the four inferior cervical nerves* diminish in size to the eighth, and are all disposed in a similar manner; they pass towards the mesial line between the different muscles, and gradually become sub-cutaneous; they then bend outwards, and are distributed to the integument covering the trapezius muscle. While the direction of the three first is principally upwards, that of the fourth and fifth is nearly transverse, and that of the three last is rather downwards.

We may next proceed to examine the anterior divisions of the four last

cervical, and at the same time that of the first dorsal, as the latter joins the former, to constitute the following very important plexus.

The Brachial Plexus is formed by the junction of the anterior branches of the fifth, sixth, seventh, and eighth cervical, and of the first dorsal. This plexus is broad and flat, the nerves forming it are very large, particularly the inferior; it is situated at the lower and lateral part of the neck, between the sealeni muscles and above the subclavian artery; it descends obliquely outwards beneath the clavicle and subclavian muscle, and over the first rib into the axilla, where it rests on the serratus magnus, behind the axillary artery and vein, and on the inner side of the humero-scapular joint and sub-scapular tendon. The fifth and sixth cervical unite first, the seventh cervical runs alone for some distance, the eighth cervical and first dorsal unite immediately, so that, at first, this plexus consists of three roots; these, however, soon unite in the following manner: The upper root, which is joined by a filament from the fourth cervical, soon divides into a superior and inferior branch; the lower root also soon bifurcates in a similar manner; lower down, or behind the clavicle, the seventh cervical or the middle root divides into a superior and inferior branch, the former joins the lower division of the upper, and the latter joins the upper division of the lower root; the three cords then converge, and the plexus becomes narrow as it enters the axilla, when it again expands and opens out into several divisions, which surround the axillary artery in a plexiform manner, and from which the terminating branches proceed. The roots of the plexus are covered by the anterior scalenus, and by a strong fascia prolonged from the margin of this muscle. It then traverses the inferior lateral triangular region of the neck, nearly parallel to but deeper seated than the omo-hyoid muscle. It next descends behind the clavicle, the subclavius muscle, the strong coraco-clavicular aponeurosis, and the greater and lesser pectoral muscle. It ends in its ultimate divisions, opposite the coracoid process. In the neck the plexus is superior and external to the subclavian artery, and distinct from it. As it descends it approaches this vessel, and in the upper part of the axilla it is almost immediately behind it, though somewhat external to it; in the middle of this region it partly embraces the artery, and inferiorly the latter is placed between the roots of the median or brachial nerve, one of its largest branches; the corresponding vein is inferior to it in the neck, and on a plane internal and anterior to it in the axilla, and never so closely connected to it as the artery is.

The numerous branches of this plexus may be arranged into two orders, one (supra-clavicular) arises above the clavicle, the other (axillary) arises below this bone. This arrangement, though convenient, will seldom be found critically correct, as the origin and disposition of some of the branches are not uniformly the same in all cases. The *supra-clavicular* branches are—First, for the subclavian muscle; this arises from the first root of the plexus; it generally gives off a filament to join the phrenic nerve, and then enters the subclavian muscle. Second, small branches also from the upper root of the plexus to the scaleni, levator anguli, and rhomboidæi muscles. Third, *posterior thoracic*, or *external respiratory*, also arises from the fifth and sixth cervical, close to the spine, and in the substance of the middle scalenus muscle; it also sometimes receives a branch from the fourth cervical. This nerve, about the size of the phrenic or internal respiratory, takes a long course; it descends obliquely outwards, behind the brachial plexus, and between the sub-scapular and serratus magnus muscles: on the external surface of the latter it descends even to its lower border, and supplies its costal fasciculi with filaments through its whole course. As this nerve arises in the neck so close to the roots of the phrenic, it must serve to associate (as Sir C. Bell has remarked) the serratus magnus muscle with the diaphragm in inspiratory efforts; hence it has been named the external respiratory nerve. Fourth,

the *supra-scapular nerve* also arises from the upper division of the plexus, descends obliquely backwards, beneath the trapezius, and parallel to the omo-hyoid muscle, to the superior costa of the scapula, enlarges and passes beneath the posterior ligament, which converts the notch in this part of the bone into a foramen ; it then gives off two considerable branches to the supra-spinatus muscle, and proceeds beneath the acromion process, behind the neck of the scapula, and in front of its spine, to the infra-spinous fossa, where it is distributed to the infra-spinatus and teres minor muscles ; it also gives off one or two delicate articular branches to the shoulder joint.

The *infra-clavicular*, or axillary branches, are, first, the thoracic ; second, sub-scapular ; and, third, circumflex ; these are to supply the pectoral muscles, the axilla, the integuments, and several of the muscles of the shoulder ; fourth, internal cutaneous ; fifth, external cutaneous, or musculo-cutaneous ; sixth, the median or brachial : seventh, the ulnar ; those four nerves are associated in function, they supply sensitive and tactile filaments to the anterior and internal aspect of the arm, forearm, hand, and fingers, and motor filaments to the extensive group of the flexor and pronator muscles ; eighth, the musculo-spiral or radial nerve. This large cord is destined to supply the extensors and supinators of the forearm, hand, and fingers, and might be named the *great extensor nerve* of the upper extremity, as the combined median, ulnar, and musculo-cutaneous may be regarded as the *great flexor*. All these nerves are probably compound, that is, their fasciculi contain both sensitive and motor filaments, excepting the internal cutaneous nerves, whose distribution is entirely to the skin. These nerves are arranged in respect to the artery in the following manner : the vessel lies between the two roots of the median nerve ; the outer root of the latter and the external cutaneous are to its outer or humeral side ; the inner root of the median, the internal cutaneous, and the ulnar, are to its inner or costal side ; the circumflex and the musculo-spiral are behind it ; and the trunk of the median is in front of it.

The *thoracic branches* are two or three short nerves, which supply the pectoral muscles, accompany the thoracic arteries, communicate freely with each other and with branches from the intercostal nerves, which cross the axilla to the integuments of the arm. These nerves also distribute filaments to the areolar tissue and glands in the axilla, and contribute to the plexiform appearance which the dissection of this region presents. The *anterior*, or more superficial thoracic nerve, arises nearly opposite the clavicle, crosses the axillary vessels, and is distributed to the deep surface of the great pectoral muscle ; small filaments also pass to the clavicular portion of the deltoid. The *posterior*, or deeper thoracic branches, pass behind the artery, and come forwards between it and the vein, form loops or plexuses with branches from the former, and are distributed to the lesser and partly to the great pectoral muscle.

The *sub-scapular nerves* are three or four in number ; they arise from different parts, but chiefly from the upper division of the plexus ; they descend behind the vessels, and ramify in the sub-scapular, latissimus dorsi, and teres major muscles.

The *circumflex*, or *articular nerve*, or *deltoid*, arises from the lower and back part of the plexus, in common with the musculo-spiral, descends round the lower edge of the sub-scapular muscle, and, passing backwards and outwards, escapes from the axilla by a large opening between the humerus and the long head of the triceps, above the tendons of the latissimus dorsi and teres major muscles, and below the capsular ligament of the shoulder joint ; it then winds round the neck of the humerus, attached to the internal surface of the deltoid to its anterior border. In this course the nerve sends some small branches to the sub-scapular, latissimus dorsi, and teres major and minor ; it then divides into two branches, a superior and inferior, both of which

encircle the neck of the humerus, and send their numerous subdivisions into the deltoid muscle. At the inferior and posterior margin of the deltoid a considerable cutaneous branch arises from the inferior division; this ascends beneath the fascia, becomes cutaneous, and ramifies in the skin, covering the lower part of the deltoid; other branches pierce the muscle higher up, and are distributed to the integuments of the shoulder; it also sends a considerable branch to the capsule of the shoulder joint, which passes to it beneath the tendon of the sub-scapular muscle. The circumflex nerve and its divisions are accompanied by the posterior circumflex artery and its branches; both are liable to be injured in fracture of the surgical neck of the humerus; and the trunk of the nerve may suffer such compression in case of dislocation of the head of the humerus into the axilla as may impair the power of the deltoid muscle. The student will find it convenient to postpone the dissection of this nerve until the other branches of the plexus have been examined, or until the arm has been detached from the trunk.

Internal cutaneous nerve is long and delicate: it arises out of the lower division of the plexus, in common with the ulnar and inner head of the median, descends nearly perpendicularly along the inner side of the arm, at first covered by the brachial aponeurosis; near the elbow it pierces the latter, becomes subcutaneous, and parallel to the basilic vein, and divides into two branches, an external and internal; the external passes along the border of the biceps over the bend of the elbow to the forearm, where it divides into several filaments, some of which descend in the integuments as low as the wrist, and communicate with the other cutaneous nerves. This branch generally crosses the median basilic vein, superficial to it, and rarely behind it; the internal branch descends towards the internal condyle, and divides into several filaments, some of which descend along the inner, and others along the posterior part of the forearm; they all terminate in the integuments. An *accessory* or *lesser internal cutaneous nerve*, or *nerve of Wrisberg*, may also be noticed in connection with that just described. This small branch, arising from the lower and back part of the plexus, descends on the back part of the arm, pierces the fascia, is distributed to the integuments about the elbow, and communicates with cutaneous filaments of the internal cutaneous and of the musculo-spiral nerves. In the axilla it often joins with the humeral cutaneous branch from the first intercostal nerve; indeed this latter branch is sometimes named "nerve of Wrisberg," and not unfrequently takes the place of the lesser cutaneous.

The *external cutaneous nerve*, or *musculo-cutaneous*, or *perforans Casserii*, is larger than the last, and arises from the upper division of the plexus, in common with the external root of the median; it descends obliquely outwards through the fibres of the coraco-brachialis, and between the brachiæus anticus and the biceps; it then descends along the outer border of the latter to the bend of the elbow, pierces the aponeurosis, becomes cutaneous, and descends along the radial side of the forearm to the wrist. In the arm this nerve gives muscular branches to the coraco-brachialis, biceps, and brachiæus anticus: in the latter muscle it frequently communicates with the median nerve. At the elbow this nerve is situated between the biceps and supinator longus, and behind the cephalic and median cephalic veins; along the forearm it accompanies this vein, and is often superficial to it. Near the wrist it divides into an anterior and posterior branch, the former passes to the ball of the thumb and palm of the hand, the latter to its dorsum, and both communicate with the cutaneous filaments of the radial nerve: this nerve does not always pierce the coraco-brachialis muscle.

The *median* or *brachial nerve* is the largest branch of the plexus; it generally arises by two roots, a small external one, which is in common with the external cutaneous from the upper part of the plexus, and a large internal

one from the lower division of the plexus, in common with the ulnar and internal cutaneous. The brachial artery in general separates these two roots, which soon unite into one thick cord; it descends obliquely outwards along the inner edge of the biceps, as far as the bend of the elbow; in this course it is covered only by the skin and fascia, is situated rather to the outer side of the artery above, crossing over it about the middle of the arm, and to its ulnar side below; at the end of the elbow it passes deep between the supinator longus and pronator teres, and lies on the brachiæus anticus; it then perforates the pronator, and descends along the middle of the forearm (hence its name,) between the superficial and deep flexors, passes beneath the annular ligament of the carpus, where its size is increased, and where it assumes a grayish or ganglionic appearance, and terminates in the palm of the hand by dividing into five or six branches. In the arm the median nerve gives but few branches, small and unimportant. In the forearm it sends several considerable branches to the superficial and deep pronators and flexors, but not to the supinators; a little below the elbow it gives off the *anterior interosseal nerve;* this accompanies the artery of the same name along the anterior surface of the interosseous membrane, and supplies the deep flexors; at the pronator quadratus it divides into two branches, a small one to supply that muscle, and a larger which traverses the interosseous space, ends in a soft, gangliform expansion, filaments from which spread over the dorsum of the carpus, and supply its several articulations. Above the wrist the median nerve is ônly covered by the skin and fascia, and sometimes by the palmaris tendon; it here gives off a superficial branch, which passes over the annular ligament, and is lost in the integuments. In the palm of the hand it first gives off a considerable branch to supply the muscles of the ball of the thumb, and then divides into five *digital branches;* the two first pass one along either side of the thumb, the third goes to the radial side of the index finger, the fourth supplies the opposed sides of the index and middle finger, and the fifth, which is joined by a small branch from the ulnar nerve, supplies the opposed sides of the middle and ring fingers. These digital branches in the palm of the hand are superficial to the tendons, and form an arch nearly parallel to that formed by the ulnar artery; the branches of the latter and the digital nerves then run together to the extremity of each finger, the nerves being on the internal side of the arteries; in this course they supply the lumbricales, the integuments of the hand and fingers: opposite the base of the first phalanx each sends off a dorsal cutaneous branch, which runs along the posterior border of each finger, and unites with the posterior cutaneous nerves; and near the last phalanx of each the nerves enlarge, become red and soft, and divide into a dorsal and palmar branch; the former is lost in the vascular matrix of the nail, and the latter subdivides into numerous fine branches, which are lost in the sentient or tactile papillæ of the cutis.

The *ulnar nerve* arises from the lower part of the plexus, in common with the internal cutaneous and the inner head of the median; descends obliquely backwards along the triceps, internal to the brachial vessels, and accompanied by the inferior profunda artery; it pierces the internal intermuscular ligament, becomes very superficial, and passes behind the elbow-joint through the groove between the inner condyle and the olecranon process, between the origins of the flexor carpi ulnaris muscle; it then passes forwards, and descends along the ulnar side of the forearm to the carpus, and, passing over the annular ligament close to the pisiform bone, ends in the palm of the hand, in two branches, a superficial and a deep. In the arm this nerve is superficial, and gives off a few branches to the triceps and to the skin; as it passes behind the inner condyle it gives off some articular and cutaneous branches. In the forearm it lies on the flexor profundus, and between the flexor sublimis and ulnaris, overlapped by the latter; the ulnar artery is to

its radial side; to these muscles it sends several filaments; a little above the wrist it becomes superficial, and gives off the *dorsalis carpi ulnaris*, a large branch which winds round the ulna, beneath the flexor carpi ulnaris, to the back of the hand, and divides into several long branches, which are lost in the integuments of that region and on the dorsum of the three inner fingers, and anastomose with the radial branch of the musculo-spiral nerve. Of the terminating branches of the ulnar nerve the *superficial* is the larger; it divides into three branches, which supply the palmaris brevis, the muscles, and both sides of the little finger, also the ulnar side of the ring finger. The *deep palmar branch* passes beneath the flexor tendons, runs across the metacarpus, and assists in forming a deep palmar arch, the branches of which supply the adductor and flexor pollicis brevis, and the interossei muscles.

Connected to the digital and other sensitive branches, both of the median and ulnar nerves, are a number of small, indurated, white bodies, now known by the name of *Pacinian Corpuscles;* so called from Filippo Pacini, who discovered them in 1830. These have since been more accurately described by him, by Henle, and others. They are most distinct on the small branches of the digital nerves: at first view they appear like globules of firm cellular membrane, of an elliptical form,* imbedded in the subcutaneous adipose tissue, and surrounded by capillary vessels; their size varies from the twentieth part of an inch upwards; each corpuscle is connected to a nerve by a short, delicate, nervous stem, which bends from it at an acute angle, and is about the eighth or tenth of an inch long. The corpuscle itself is found to be composed of a great number of delicate, concentric, membranous capsules, with intervening clear fluid; on the presence of the latter the size of the corpuscle chiefly depends, as on puncturing it, it collapses into a mere flattened band; the central capsule is also filled with fluid. The stem contains a minute nervous filament, which perforates the several capsules, becomes pale, flat and small, and traverses the central cavity in a straight line to its remote end, where it adheres, and is said to terminate, not in a plexus or loop, but in an adherent pulp or bulb. The use or function of these bodies is unknown, but from the uniformity of their existence we may presume they are the seat of some peculiar vital or nervous agency: they are not seen on any of the true motor nerves; they have been found in other situations besides the hand, as the sole of the foot, on the cutaneous nerves of the limbs, and of those of the intercostal spaces, and on the great plexuses. They are said to occur in great numbers in the sympathetic plexuses in the mesentery and mesocolon in the cat. Pacini endeavors to establish a structural analogy, and would thence infer one in function, between these corpuscles and those very remarkable electric organs found in certain fish, as in the electric ray, near the head, and in the electric eel, near the tail. These organs consist of membranous prisms or columns filled with fluid; they are of an hexagonal and triangular form, and are subdivided by transverse septa, on which are distributed the terminal plexuses of nerves and vessels. On these partitions, however, (according to Wagner; *see* Wagner's Comp. Anatomy, translated by Tulk, page 219), the nerves terminate, not, as in the Pacinian corpuscles, in adherent bulbs, but much in the same way as they do on the voluntary or transversely striated muscles.—(*See* British and For. Med. Review for Jan., 1845, p. 78). A minute and very interesting account of the structure of these singular bodies, microscopically examined, has been lately published by Todd and Bowman (*see* Phys. of Man, p. 400).

The *musculo-spiral* or *radial nerve* is the largest branch of the plexus; it proceeds from its middle and lower divisions in common with the circumflex nerve, descends obliquely backwards and outwards, between the three por-

* See preparation of these in the Museum of Trinity College.

tions of the triceps and the humerus, to the external side of the latter; it then turns obliquely forwards and downwards towards the elbow, between the supinator longus and the brachiæus anticus, and there divides into two branches, an anterior or radial branch, a posterior or interosseal branch; it is accompanied by the inferior profunda artery. In its course down the arm this nerve sends several branches to the triceps, and to the integuments on the inner and posterior part of the arm, also to the elbow; a little above the outer condyle it gives off a large cutaneous branch, which descends along the radial side of the forearm to the thumb. At the bend of the elbow this nerve sends several branches to the long and short supinators, also to the extensors of the carpus. On the surface of the supinator brevis it expands and divides into its two terminating branches. The *anterior* or the *radial nerve* descends along the inner side of the supinator longus, which it supplies, and lies external to the radial artery. About the middle of the forearm, or a little lower, this nerve passes behind the tendon of the supinator longus, and, becoming cutaneous, descends behind the radius to the back of the hand, where it divides into two considerable branches; one supplies the integuments of the radial side of the thumb, and communicates with the posterior branch of the external or musculo-cutaneous nerve; the other, or the internal branch, crosses the extensor tendons of the thumb, expands on the dorsum of the hand, and supplies the inner border of the thumb, and the index and middle fingers, and communicates with the dorsalis ulnaris nerve. The *deep* branch of the musculo-spiral, or the *posterior interosseal nerve*, is larger than the radial, winds backwards round the upper part of the radius and the supinator brevis; it then descends along the back part of the forearm, with the posterior interosseal artery, and divides into several branches, superficial and deep, which supply the two layers of extensor muscles.

The Dorsal Nerves are twelve in number on each side. The first pair passes between the two first dorsal vertebræ, and the last pair below the two last dorsal vertebræ; the first is very large, the following diminish in size, but the two last again increase, and the twelfth is nearly equal to the first. These nerves are distributed to the parietes of the thorax and abdomen, also to the muscles and integuments on the posterior and lateral regions of the trunk; they are not connected together in any plexus, like the cervical, lumbar, and sacral nerves, but are distributed separately; all their anterior branches, however, are united through the medium of the chain of the dorsal sympathetic ganglions, each of the former being connected by one or two filaments to one of the latter; the first dorsal is also joined to the last cervical in the brachial plexus, and the last dorsal is connected to the first lumbar: they all divide into a posterior and an anterior or intercostal branch. The *posterior* or *dorsal branches* are smaller than the anterior; they each pass backwards, accompanied by the posterior branch of the intercostal artery, through a foramen bounded above and below by the transverse processes, internally by the bodies of two vertebræ, and externally by the anterior or great costo-transverse ligament; they supply the muscles and integuments of the back and loins.

To obtain a view of the posterior dorsal nerves, place the body on its fore-part, divide the skin along the spine from the neck to the loins, and dissect it over towards the scapula and side of the thorax and abdomen. Several long nerves will be met with in this dissection, which, having pierced the trapezius, rhomboid, latissimus dorsi, and inferior serratus, are distributed to the integuments of this region. Some of the *superior cutaneous nerves* of the back pierce the laminæ of dorsal muscles close to the spinous processes, and then pass transversely outwards towards the scapula, and some ascend. The *inferior cutaneous* perforate the latissimus dorsi and inferior serratus on a plane external to the superior nerves, nearly opposite the angles of the ribs; these nerves ramify on the lower part of the back, chiefly in a direction downwards,

and some branches extend over the lumbar to the glutæl and sacral regions. By a little dissection they may be followed deep among the muscles to the cellular line, between the sacro-lumbalis and longissimus dorsi, and beneath or through the latter to the foramina, between the transverse processes. The six superior escape from these between the semi-spinalis dorsi and multifidus spinæ, and the six inferior between the latter and the longissimus dorsi; these increase in size as they descend; they all divide into two branches, an *internal* and an *external;* the former supply the long erector or extensor muscles of the spine, the latter pass through these, supplying them at the same time, and are chiefly distributed to the broad superficial muscles which they perforate; both also furnish the cutaneous branches; superiorly these are chiefly derived from the internal muscular branches, but inferiorly from the external muscular and musculo-cutaneous.

The anterior dorsal nerves are named, from their situation, intercostal, with the exception of the first, which joins the last cervical in the brachial plexus, first giving off a small intercostal branch; the remaining eleven are disposed in a somewhat similar manner; they all pass round the parietes of the thorax, between the laminæ of the intercostal muscles, and inferior to the bloodvessels of that name; the superior five or six are confined to the chest, and extend as far as the sternum, but the anterior portions of the five or six inferior are placed in parallel lines between the abdominal muscles, and extend to the rectus; they supply the parietes, muscles, and integuments of the thorax, and of the upper part of the abdomen; also some cutaneous filaments to the arm; they all communicate by two short branches with the thoracic ganglions of the sympathetic, which are placed on the side of the spine; they diminish in size as they descend, except the two last: the twelfth is nearly as large as the first, it often communicates with the first lumbar by a small branch called *dorso-lumbar nerve;* this is not always present; the connection is then maintained through the sympathetic. These nerves may be exposed either by raising one or two of the external intercostal laminæ, or by breaking and everting the ribs on one side, raising the pleura, and dividing some of the internal laminæ of the intercostal muscles. Each intercostal nerve is separated from the posterior branch by the costo-transverse ligament; it then becomes flattened, and passes first between the pleura and a strong fascia, which occupies the place of the internal lamina of the intercostal muscles; it then enters the interstice between the internal and external intercostals, beneath the groove which lodges the artery and veins; as it passes forwards it descends near to the centre of the intercostal space, and, about midway between the spine and sternum, divides into a superficial or cutaneous branch and the continued intercostal. The *first anterior dorsal* is very large, and is an exception to this description; it ascends from the thorax into the neck, in front of the neck of the first rib, has a very close connection to the large ganglionic mass which the sympathetic here presents, and joins the eighth cervical nerve; it first sends off a small intercostal branch, which runs forwards between the first intercostal muscles towards the sternum, and ends anteriorly in a small cutaneous filament. The *second intercostal* proceeds in like manner in the second space; about midway it gives off a large branch, which passes outwards to the integuments of the arm; this is named the *first intercosto-humeral*, and, by some, the nerve of Wrisberg. The *third intercostal nerve* very often, but not always, gives off a similar branch, the *second intercosto-humeral nerve;* both these nerves perforate the costal origins of the great serratus, pass outwards across the axilla, communicate with each other and with the thoracic branches of the brachial plexus, and with the lesser internal cutaneous one of the arm, and finally terminate in the skin on the posterior and internal part of the arm, descending even to the elbow. The *five* or *six superior intercostal nerves* continue forwards as far as the costal cartilages, then rest upon the pleura,

cross the internal mammary vessels and some fibres of the triangularis sterni muscles, send some filaments to the latter, and finally pierce the internal intercostal and great pectoral muscles, and end in the integuments in a series of small branches, named *anterior cutaneous nerves.* Besides these cutaneous branches, they all, except the first, give off the *lateral cutaneous nerves;* these pierce the external intercostals and the anterior border of the great serratus, give off small muscular branches, become sub-cutaneous, and divide each into an anterior and posterior branch, which supply the integuments; the anterior branches turn forward towards the anterior cutaneous nerves, and some are distributed to the integuments of the breast; the posterior pass backwards to the skin over the inferior costa of the scapula and over the latissimus dorsi muscle.

The *five* or *six lower intercostals* (not the last) pass in a similar manner in the intercostal spaces, and at the anterior extremity of each, where the cartilages bend upwards, they pass forwards parallel to the intercostals above, between the internal oblique and transverse muscles of the abdomen, as far as the outer edge of the sheath of the rectus, perforate this along its outer border, pass behind the muscle, and about its centre perforate it, and divide into muscular and anterior cutaneous branches; the latter pass through the anterior wall of the sheath, along the side of the linea alba, and are reflected transversely outwards in the integuments. In this course these nerves supply the intercostal and the abdominal muscles, send small filaments to the diaphragm, communicate with each other, and about midway between the spine and the linea alba each sends off a lateral cutaneous nerve; these pierce the external intercostal and abdominal muscles nearly in the same line as those from the upper intercostals; they become subcutaneous, and divide into anterior and posterior cutaneous filaments; the anterior branches are continued forwards to communicate with the anterior perforating cutaneous branches from the sheath of the rectus, and the posterior are continued round over the external oblique and latissimus dorsi to meet the posterior cutaneous nerves from the posterior dorsal. The anterior branch of the *last dorsal* is abdominal rather than intercostal; it is very large, and generally communicates with the first lumbar close to the spine by the dorsal lumbar branch; it then runs below the last rib, crossing the quadratus lumborum, and the diaphragm, to which it gives some filaments, and, piercing the anterior leaf of the transversalis tendon, it passes forwards, like the other nerves, between the transverse and internal oblique muscles to the sheath of the rectus; between the ilium and last rib it gives off its lateral cutaneous branch, which is very large, pierces and supplies the two oblique muscles, descends almost vertically over the crest of the ilium, and divides into anterior, middle, and posterior cutaneous filaments, which ramify over the gluteal, iliac, and trochanteric regions.

Lumbar Nerves.—Of these there are five pair; they are larger than the dorsal, and increase in size from above downward: the first escapes between the two first lumbar vertebræ, and the fifth between the last vertebra and the sacrum; like the dorsal they divide into posterior and anterior branches. The *posterior* pass between the transverse processes to the lumbo-spinal muscles, and each divides close to the multifidus spinæ into an internal and external branch; the former is lost in the multifidus spinæ, inter-spinous, and inter-transverse muscles; the external branch is larger and musculo-cutaneous; it supplies the sacro-lumbalis and lumbar aponeurosis, pierces the latter, and is lost in the integuments. The two last posterior nerves are very small, and are distributed to the integuments of the gluteal region.

The *anterior* branches are much larger than the posterior, and increase as they descend; they all pass obliquely downwards and outwards in the psoas magnus, and separate the origin of this muscle into two planes, much in the

same way as the cervical plexus divides the scaleni. In this muscle they unite with each other by a series of loops, each nerve dividing into two or more, and the branches arch up and down to join the corresponding nerve above and below. This plexiform arrangement of these nerves resembles that in the cervical more than the brachial or sacral plexus. The first lumbar is usually connected to the last dorsal, and the fourth lumbar is joined to the fifth, which does not enter this plexus, but descends into the pelvis, under the name of the lumbo-sacral nerve, to join the great sacral plexus. Each of the anterior lumbar nerves is joined to the long ganglions of the sympathetic, and, as these are placed on the forepart of the vertebræ, these connecting filaments are much longer than those in the back.

The *lumbar plexus* is long and somewhat triangular, broad below and narrow above, is situated along the sides of the lumbar vertebræ, in front of their transverse processes, and near the posterior surface of the psoas magnus muscle; in addition to its three principal and terminal branches, the anterior crural, obturator, and lumbo-sacral, it also gives off some long superficial branches.

The *superficial branches* of the lumbar plexus are variable in number, size, and exact situation; they supply the inferior portion of the abdominal muscles and integuments, the integuments of the groin, and upper and outer part of the thigh; also those of the inguinal and pubic regions: they are, therefore, abdomino-crural and genito-crural. They are differently named by different writers: the arrangement adopted by Bichat appears as appropriate as that of more modern authors. He enumerates four, viz., the superior, middle, and inferior musculo-cutaneous, and the genito-crural.

Superior musculo-cutaneous (external ilio-inguinal, or ilio-hypogastric, or ilio-scrotal.)—This, like the following branches, is exposed by detaching the peritoneum from the lumbar and iliac fossæ; it arises from the upper root or roots of the plexus, traverses the psoas, and gives it some filaments; then proceeds obliquely outwards, on the quadratus lumborum muscle and behind the kidney, to the posterior part of the crest of the ilium, enters a groove between this and the transversalis muscle, and divides into an external and internal branch. The external is distributed to the abdominal muscles and integuments; the internal passes forwards towards the anterior iliac spine, then proceeds parallel to the crural arch, and near the rectus perforates the external oblique, and becomes cutaneous in the inguinal and pubic regions. Near the ilium it gives off a cutaneous branch, which passes over the bone, and is distributed to the integuments over the glutæus medius, behind the lateral cutaneous branch of the last dorsal nerve.

The *middle musculo*, or *inguino-cutaneous*, arises close to the last, and has nearly a similar course and termination.

The *inferior musculo-cutaneous*, or *external cutaneous*, is a small, long branch arising from the first and second lumbar, descends along the iliac fossa, escapes into the thigh between the superior and inferior iliac spinous processes, and divides into two branches. The posterior passes backwards behind or through the tensor vaginæ, and becomes subcutaneous on the upper, outer, and back part of the thigh. The anterior branch perforates the fascia lata three or four inches below the arch, and ends in long cutaneous filaments, which descend towards the knee, along the outer and anterior aspect of the thigh.

The *genito-crural nerve* arises from the second and third lumbar, descends obliquely through the psoas, in front of or connected to the external iliac artery, and divides into the genital or spermatic and crural branch. The spermatic pierces the transverse fascia, or escapes through the internal ring, joins the cord, descends at first posterior to it, gives off cutaneous filaments, supplies the cremaster, and is lost in the scrotal and pubic integument; in

the female it accompanies the round ligament, and ends in the labium. The crural branch accompanies the external iliac artery beneath the arch, crosses the root of the circumflex ilii branch, pierces the sheath of the vessels and the fascia lata, sends some filaments along the artery, and is distributed to the inguinal integuments and glands.

The *anterior crural nerve* arises in the lumbar plexus from the four superior nerves, but principally from the third and fourth; it is the largest and the most external branch of the plexus, and is destined to supply the integuments on the anterior and inner aspects of the thigh, leg, and foot, also all the extensor muscles of the leg or of the knee-joint, and the principal flexors of the thigh or of the hip-joint, flexion of the latter and extension of the former being associated in locomotion. It perforates the psoas, descends obliquely outwards, along its external side, in the groove between it and the iliacus internus, covered by the iliac fascia; it passes beneath Poupart's ligament about half an inch external to the femoral artery, separated from it by the psoas and by the iliac fascia, and is thereby excluded from the sheath of the vessels. It is next covered by the fascia lata, becomes flat and broad, and divides into two fasciculi, a superficial and a deep, between and among which the branches of the external circumflex artery are entangled. Within the abdomen the anterior crural nerve gives off one or two filaments to the psoas and several to the iliac muscles, and sometimes one or two to the external iliac or femoral artery. The superficial or anterior division of the nerve subdivides into several muscular and musculo-cutaneous branches, which pierce the fascia lata, and descend along the inner and forepart of the thigh to the knee. It would be useless and almost endless labor to apply distinct names to all the individual branches of this long nerve, neither could any one description apply to all cases, as the exact point of their origin, as well as of their separation and subdivision, is very variable. If the integument be carefully raised from the anterior and lateral aspects of the thigh, from the pelvis to the knee, several long cutaneous nerves will be exposed, in addition to those already traced from the lumbar plexus. Many of these cutaneous nerves are rather large, and are seen to perforate the fascia lata by distinct oblique canals, carrying with them, in some instances, a sheath from the fascia; they descend between the skin and aponeurosis to a variable distance, at first isolated from the surrounding parts; they soon enter the subcutaneous tissue, and their filaments separate and scatter, some pass transversely, others loop upwards in arches convex inferiorly. Near the knee the terminating filaments become soft, enlarged, and ganglionic, and end in the subcutaneous adipose tissue around the patella. When the cutaneous filaments have been thus exposed, the fascia lata may be next divided and partially raised, so as to bring into view the trunk of the anterior crural at the seat of its expansion and division. This point, however, is variable, as the nerve often separates into many of its branches higher up, even in the iliac fossa.

The principal branches of the *superficial division* of the anterior crural nerves are the middle cutaneous, the internal cutaneous, the vaginal branches to the sheath of the vessels, and the long saphenous; the branches of the deep division are wholly muscular. These two divisions are variable as to size, and therefore some branches, which are usually described as arising from one, may be found to proceed from the other. This separation or distinction into two portions appears to me to be merely caused by the accidental passage of the external circumflex artery through the fasciculi of the nerve.

The *middle cutaneous*, or *musculo-cutaneous nerve of the thigh*, perforates the sartorius very obliquely, gives some branches to it, then pierces the fascia lata three or four inches below Poupart's ligament, and soon divides into long fasciculi, which descend towards the inner and forepart of the knee, sending off numerous filaments to the skin, which communicate with other cutaneous

nerves. Not unfrequently two or three nerves will be found to correspond to this description.

The *internal cutaneous nerve*, or nerves, descend in the line of the femoral artery to its outer side, supply the sartorius, and either perforate it or pass at one side of it, pierce the fascia lata about the middle of the thigh, and descend towards the inner side of the knee, where they end in numerous branches; some bend forwards towards the patella, end in the skin and in a subcutaneous plexus along with the other superficial nerves. In the upper parts of the limb this nerve gives small filaments to the sheath of the femoral vessels; others pierce the fascia at irregular intervals along the inner side of the limb; and some escape through the saphenous opening, or in its vicinity (*superior* or *short saphenous*), and accompany the saphena vein along the thigh; some of the deep branches communicate with the inferior or long saphenous and with the obturator nerve, forming an interlacement beneath the sartorius muscle in the course of the femoral vessels.

Vaginal branches pass inwards to the sheath of the vessels; some twine around the artery, and pass between it and the profunda towards the pectinæus; others join in the general interlacement between the muscular branches and the obturator, and one very generally passes in front of the artery, above the middle of the thigh, in its course to the adductor longus muscle.

Inferior, or *long saphenous nerve*, sometimes arises wholly or in part from the deep division of the anterior crural, descends obliquely inwards, at first on the outer side of the artery, afterwards in front of it; passes along with this vessel into its tendinous sheath or canal in the middle third of the thigh, but separates from it at the opening in the adductor tendons, through which the artery glides backwards into the poplitæal space, the nerve continuing to descend vertically, accompanied by the anastomotica magna artery, and crossing the adductor tendon obliquely from before backwards arrives at the inner side of the knee, a little behind the internal condyle of the femur; becomes subcutaneous between the tendons of the gracilis and sartorius, anterior to the former, and sometimes perforating the latter; and then divides into two branches, the cutaneous nerve of the knee and the proper saphenous or internal cutaneous nerve of the leg. In the upper part of the thigh it communicates by small filaments with the obturator and with branches of the internal cutaneous, and with the muscular branches of the anterior crural nerve. These communications are very variable: I have seen it receive a considerable branch from the obturator, in other cases I have not found any direct connection between these nerves; while in the femoral sheath, in the middle of the thigh, it sometimes gives off a small cutaneous branch, also some filaments to the vastus internus and sartorius. Near the opening in the adductor tendon it gives off an articular branch, which descends along the adductor tendon in company with a small artery, and is distributed to the synovial membrane. The internal cutaneous nerve of the knee or patellary branch is a large flat nerve, which sometimes perforates the sartorius tendon, and arches forwards over the inner side of the joint to the margin of the patella, divides into three sets of branches, superior, middle, and inferior or descending; they all ramify in the integuments around the patella and over the upper part of the tibia and ligamentum patellæ, and communicate with the other cutaneous nerves of this region. The proper saphenous nerve continues to descend, crosses the tendon of the gracilis, and joins the internal or great saphena vein, which it accompanies as far as the foot, twining around it, occasionally splitting, and the divisions encircling the vessel and reuniting. In this course it distributes numerous filaments to the integuments on the forepart of the tibia, some also to the inner and back part of the leg, which communicate with the posterior saphenous or cutaneous nerve of the leg; it descends nearly parallel to the inner border of the tibia, and near the malleolus divides

into two principal branches; one descends to the inner ankle, and subdivides into cutaneous filaments for that region; the other, the larger branch, accompanies the vein in front of the malleolus, and divides into numerous filaments, some of which supply the synovial membrane, others expand on the dorsum and inner side of the foot, along with the cutaneous veins, and communicate with the dorsal nerves of the foot derived from the peronæal nerve.

The *deep fasciculus of the anterior crural* is larger than the superficial; it immediately divides into numerous muscular branches, which supply the muscles on the outer and forepart of the thigh, and partly also those on the inner. These branches may be arranged into three sets, an external, middle, and internal: the first supply the vastus externus, rectus, and iliacus internus, also a small branch to the tensor vagina, this muscle being also supplied from the superior gluteal nerve; the middle set supply the sartorious in part, but principally the cruræus and vastus internus; the internal set accompany the femoral artery; one or two pass behind it, and supply the pectinæus; some filaments also pass to the adductor longus, and the remainder to the inner surface of the vastus internus. Almost all these muscular nerves take a descending course, and are accompanied by large bloodvessels, branches of the external circumflex artery and vein, and are all surrounded by much adipose and areolar tissue; the principal branches follow the intermuscular spaces between the two vasti and cruræus, also between the latter and the rectus. Some of the external are very large and long, and in their descent give off cutaneous branches to the outer and posterior part of the thigh, which pierce the vastus and fascia lata below the insertion of the glutæus maximus; some long filaments descend between and beneath the muscles on the periosteum to the synovial membrane of the knee-joint.

The *obturator nerve* arises chiefly from the third and fourth lumbar, perforates the psoas, and descends obliquely inwards, along the inner side of that muscle, above the pelvic cavity and obturator vessels, and in the angle between the internal and external iliac arteries, to the obturator foramen, through the upper part of which it passes to the inner side of the thigh, where it is covered by the pectinæus, and where it divides into its two branches, an anterior and posterior; the anterior or superficial branches are lost in the gracilis, adductor brevis, pectinæus, and vastus internus, and communicate with the internal saphenous and vaginal branches of the anterior crural; some also perforate the fascia, and become cutaneous on the inner side of the thigh: from the pectinæal and adductor branches articular filaments pass to the inner side of the hip-joint, to supply the synovial membrane, and accompany the articular artery through the notch in the acetabulum. The posterior or deep branches supply the obturator externus and adductor magnus; some branches perforate the latter, and supply the adductor longus, and proceed as far as its lower border; some filaments then become superficial, others join internal branches of the anterior crural, and several supply the adductor magnus; one long branch may be traced through it to the lower part of the thigh, into the poplitæal space, and along the poplitæal artery to the back part of the knee-joint. A small nerve from the lumbar plexus (*accessory obturator*) is occasionally met with; this nerve arises from the fourth lumbar, perforates the psoas, descends on its pelvic side, over the pubis, passes beneath the pectinæus, and ends in several branches; some join the obturator nerve, others are articular, and the remainder are distributed to the pectinæus and adductor brevis muscles.

The *lumbo-sacral nerve* is the largest branch of the lumbar plexus, is formed by a large portion of the anterior division of the fourth and the whole of that of the fifth lumbar nerves, enters the pelvis close to the base of the sacrum, internal but near to the sacro-iliac synchondrosis, and behind the iliac vessels: it immediately divides into two branches; one, the *communi-*

cating, is inferior or anterior, and joins the first anterior sacral nerve, and forms a part of the sacral plexus; the other, posterior and superior, is the *great* or *superior glutæal nerve.* This escapes from the pelvis, along with the glutæal artery and veins, through the upper and anterior part of the great sacro-sciatic foramen, and above the pyriformis muscle; is then bent forwards, and ends in two long branches beneath the glutæus medius, which are destined to supply this and the glutæus minimus and tensor vaginæ femoris muscles. One branch ascends and bends semicircularly along the iliac attachment of the glutæus minimus muscle, supplies it and the medius, and is accompanied by the superior deep branch of the glutæal artery. The inferior branch descends over the glutæus minimus in a layer of loose cellular tissue beneath the medius, supplies both these muscles, and passes obliquely forwards and downwards towards the space between the great trochanter and spine of the ilium, and is lost in the tensor vaginæ muscle.

The Sacral Nerves are six pair: they form their ganglions and divide within the spinal canal into anterior and posterior branches. The *posterior sacral nerves* are very small, pass through the posterior sacral holes, and supply the muscles and integuments of the sacral and glutæal regions: the three superior are covered at their exit from the sacrum by the multifidus spinæ muscle, and divide, as all the other posterior spinal nerves, into internal and external branches. The internal are small, and end in the adjacent muscles and tendons; the external communicate and form loops with each other and with the last lumbar, and distribute their branches to the sacro-sciatic ligaments, glutæus maximus, and integuments. The three inferior are smaller, and are lost in the fibrous structure and integument of the coccygæal region: both the anterior and posterior divisions of the fifth and sixth nerves are very small, and the student must pursue a careful dissection to expose them; the sixth is very minute, and cannot in all cases be found. I do not think it always exists, except as a part of the fifth, which it may have joined in the canal; it may be questioned whether there are six distinct pairs of sacral nerves. Bichat states that the sixth is not always to be found externally, although its ganglion is never wanting in the canal. Although I have occasionally seen it, yet it has been extremely minute, and in some cases I have looked for it in vain.

The *anterior sacral nerves* are very large, particularly the three superior; the three last are much smaller, and the sixth is very minute, and not always present. The four superior, with the branch from the last lumbar, form the *sacral plexus*, broad and flat, placed on the sacrum and pyramidal muscle, behind the pelvic fascia, which separates it from the internal iliac vessels, from the rectum, and from the other pelvic viscera; its form is somewhat triangular or palmate, the four sacral nerves corresponding to the fingers, and the lumbar branch to the thumb, and the five cords converge to the sciatic foramen. The first sacral, very large, descends obliquely outwards in front of the pyriform muscle, and is joined by the lumbo-sacral; the second sacral, also very large, descends more obliquely outwards into the plexus; the third, much smaller, passes horizontally outwards to the plexus, at some distance below the second; a branch generally unites these in front of the pyriformis; the fourth is considerably smaller, and only a portion of it directly enters the plexus, the remainder of it is distributed to the pelvic viscera; the fifth and sixth do not enter the plexus, but communicate together, as the former does with the fourth. Each of the sacral nerves, immediately after its emergence from the foramen, is joined by a short branch from one of the ganglions of the sympathetic. It sends off the following branches, both internal and external; the internal or pelvic are the hæmorrhoidal, vescical, and muscular, and in the female the uterine and the vaginal; the external branches are the inferior or lesser sciatic, the inferior glutæal, posterior cutaneous, pudic, and

great sciatic or posterior crural. All these escape by the lower part of the great sciatic notch, below the pyriform muscle. To expose the *visceral branches,* as well as the early course of some of the external, the lateral section of the pelvis should be made in the manner directed at page 257 ; the large veins must be emptied, and all the blood carefully washed out. The *visceral branches* arise from the fourth and fifth sacral, but chiefly from the fourth ; they are directed forwards into the cavity, and are joined by numerous filaments from the sympathetic nerve, which form the hypogastric plexus, a complex network of nervous filaments entangled around the branches of the internal iliac artery, and accompanying these to their terminations. This plexus will be described hereafter with the sympathetic nerve.

The internal or *pelvic muscular* branches supply the levator ani, obturator internus, pyriformis, and sphincter ani. The levator ani of each side receives two branches from the fourth sacral, besides small filaments from the vesical and hæmorrhoidal. The internal obturator nerve arises from the upper part of the plexus, that is, from the lumbo-sacral and first sacral nerves ; it accompanies the internal pudic artery through the great sciatic foramen, around the spine of the ischium, and then passes forwards and inwards through the lesser sciatic foramen, and divides into three or four branches which expand among the fasciculi of the obturator internus muscle. The pyriform muscle receives two or more filaments from the second, third, and fourth roots of the plexus ; the sphincter muscles and the lower extremity of the rectum are supplied by the inferior hæmorrhoidal nerves, which may either arise from the internal pudic, behind the spine of the ischium, or along with it from the lower part of the plexus. The posterior part of the anal region and the coccygæus muscle are also supplied by the terminal filaments of the fifth and sixth nerves. The *lesser sciatic*, *inferior glutæal*, and *posterior cutaneous nerves,* may be all regarded as one large, loose, and flat fasciculus, escaping from the pelvis along with the sciatic artery, below the pyriform muscle, internal but rather superficial to the great sciatic nerve, and covered by the glutæus maximus : this fasciculus passes over the gemelli and quadratus femoris muscles, and separates into the above-named branches. The *inferior glutæal nerve* sends off numerous muscular branches to the glutæus maximus, also cutaneous branches, which descend beneath this muscle to its lower border, become superficial, and run in different directions : some ascend in the integument of the nates. The *lesser sciatic nerve* passes downwards to the space between the tuber ischii and trochanter major, but nearer to the former, round which it twines, and at its lower part divides into two sets of branches, a superficial and a deep ; the former pass over the hamstring muscles with the posterior cutaneous nerve, and are lost in these muscles and in the integuments, one long cutaneous branch passes along the ramus of the ischium to the perinæum, and is lost in the scrotum or labium ; and the latter pass deeper, and are distributed to the quadratus femoris, upper part of the abductor magnus muscles, &c., and some go to the hip-joint. The *posterior cutaneous nerve* descends obliquely outwards, beneath the glutæus maximus, over the tuber ischii and origin of the hamstrings ; it here gives off numerous superficial branches, and then descends along the back of the thigh, beneath the fascia lata, as far as the upper part of the leg ; it then pierces the fascia, becomes subcutaneous, and communicates with the external saphenous nerve.

The *pudic nerve* arises from the third and fourth sacral, passes through the great sciatic notch or foramen, internal to the preceding, and is accompanied by the pudic artery ; it then re-enters the pelvis by the lesser sciatic notch, d passes upwards and forwards along the internal surface of the tuber chii towards the pubis, covered by the obturator fascia, and lying inferior o the artery. It then divides into two branches, an inferior and superior ; the inferior branch, or the perinæal nerve, is the larger ; it ascends obliquely

forwards and inwards along the ramus of the ischium to the perinæum, and is distributed to the muscles and integuments in that region; its branches accompany the perinæal branches of the artery, some to the anal region, some to the tuber ischii, but the largest follow the anterior branches; one to the bulb and corpus spongiosum of the urethra is seen among the fibres of the triangular or interosseous ligament. The superficial perinæal branch, in the male, is of considerable size, is placed at first beneath the superficial fascia of this region, forms a scattered plexus or network in the cellular tissue, entangled with numerous subcutaneous veins; as it proceeds towards the scrotum it becomes more superficial, and is finally expended in this cutaneous process. In the perinæum, between the scrotum and anus, I have seen the nerves of opposite sides communicate; they are also joined by cutaneous filaments from the lesser sciatic. The superior branch continues its course along the ramus of the pubis near to the symphysis, along with the terminating branch of the pudic artery; it then passes between the subpubic veins and the layers of the suspensory ligament, and turns forwards along the dorsum of the penis, superficial to the artery, and runs along the median line, increasing in size as it approaches the glans penis, in the subcutaneous cellular tissue of which it terminates. Near the attachment of the crus penis to the pubis it sends a small branch into the corpus cavernosum; on the dorsum of the penis it gives off a large cutaneous branch, which passes obliquely upon the side of the organ, and divides into numerous long filaments, some of which expand on the surface of the corpus cavernosum, others in the skin and subcutaneous tissue as far as the prepuce: the continued dorsal nerve runs more deeply along the median line as far as the corona glandis; here it expands considerably, acquires a reddish, ganglionic appearance, sinks between the crus and the glans, and penetrates the latter in delicate filaments, which can be traced to the fine papillary integument covering this organ. In the female the internal pudic nerve is much smaller than in the male; its inferior or perinæal branch is distributed to the labium, to the side of the vagina, and to its bulb and constrictor muscle; the superior branch, still smaller, passes beneath the arch of the pubes to the dorsum and substance of the clitoris.

The *great sciatic*, or *posterior crural nerve*, is the principal branch of the sacral plexus, and the largest nerve in the body; it proceeds from the four superior sacral nerves, forms a flat, broad band, which escapes from the pelvis below the pyriform muscle, sometimes through it; it soon becomes of a round form, and descends close to the outer side of the tuber ischii, along the back of the thigh, over the obturator tendon, the gemini, quadratus, and adductor magnus muscles, as far as the ham, where it divides into the external and internal popliteal nerves. In this course it is covered superiorly by the glutæus maximus and the hamstrings, inferiorly by the fascia lata and the integuments; while sunk in the fossa, between the tuber ischii and great trochanter, it is covered by a considerable quantity of adipose tissue and by the thick folded margin of the glutæus maximus; below this, or opposite the depression below the nates, it is only superficially covered for a short extent. It is next concealed by the biceps, semi-tendinosus, and membranosus; and lower down, where these muscles diverge, it is again only superficially covered, and continues so to its division: a small artery from the sciatic accompanies it, and is often inclosed between its fasciculi. This vessel maintains frequent inosculations with the perforating branches of the profunda along the back of the thigh; these inosculations have been found wonderfully increased in number and in size in cases where the femoral artery had been successfully tied long previous to death, and where collateral circulation had been fully established. The sciatic nerve sends off several cutaneous and muscular branches; the latter supply the three hamstrings, the gracilis, and

the adductor magnus. While passing over the quadratus muscle it sends off some articular filaments to the hip-joint, and about the middle of the thigh it often gives off a large articular nerve for the outer side of the knee-joint. This *external articular nerve* arises as often from one of the poplitæal divisions as from the trunk itself; its course is superficial, and parallel to the biceps tendon, downwards and outwards to the external condyle, where it divides into numerous filaments directed forwards, and distributed to the external side of the joint. Although the sciatic nerve generally bifurcates below the middle of the thigh, or at the superior angle of the poplitæal region, yet this division may occur much higher, and not unfrequently it is found at the sciatic foramen, above the spine of the ischium, with a fasciculus of the pyriform muscle interposed. In all cases a little forcible traction can separate the nerve into its two portions from the ham to the pelvis.

The *external poplitæal*, or the *peronæal nerve*, is the smaller division, and may be first pursued, as its general distribution is more superficial than that of the other; it is destined to supply the muscles on the external and anterior aspect of the leg, as well as the integuments of the leg and dorsum of the foot; it descends obliquely outwards, along with the biceps tendon, to the external condyle of the femur, superficial to the external heads of the gastrocnemius and solæus; it then turns forwards through the peronæus longus, round the neck of the fibula, and divides into two branches, the musculo-cutaneous and anterior tibial. The peronæal nerve, before it arrives at the head of the fibula, sends off two or three long branches, termed the *external cutaneous nerves of the leg*. Some of these descend along the outer and back part of the limb, and supply the integuments as low as the outer ankle; and one, the *communicans peronæi*, passes backwards over the outer part of the gastrocnemius, and communicates with the external or posterior saphenous nerve, a branch of the posterior tibial, which will be described hereafter. Some filaments of this communicating nerve are also distributed to the integument of the back of the leg and heel; the communicans peronæi often arises so high as the upper part of the poplitæal space. As the peronæal nerve passes round the joint it gives off articular and cutaneous branches.

The *musculo-cutaneous nerve* descends at first in the substance of the peronæus longus, and then between it and the extensor digitorum longus; to these and to the short peronæi muscles it sends several muscular branches; about the middle of the leg it perforates the fascia, between the peronæus longus and brevis, and a little above the outer malleolus it divides into the internal and external tarsal nerves, or *dorsal nerves of the foot*. The *internal* is distributed to the integuments of the first and second toes, and communicates with the internal saphenous nerve and with the anterior tibial. The *external* supplies the integuments on the three outer toes, and communicates with the internal branch and with the external saphenous nerve.

The *anterior tibial*, or *interosseous nerve*, descends obliquely forwards, along with the anterior tibial artery, between the tibialis anticus and the extensor digitorum longus and extensor pollicis, which muscles it supplies; it also sends branches through the fascia to the integuments. In this course down the leg it accompanies the anterior tibial artery, lying at first to its outer side, and then in front of it; but near the ankle it is again external to it, and then passes along with it, beneath the anterior annular ligament, over the synovial membrane, and inclosed in a sheath along with the extensor pollicis tendon. On the tarsus it divides into an external and internal branch; the external or tarsal passes outwards beneath the extensor brevis muscle, close to the tarsal bones and joints, divides into several reddish and expanding filaments, which supply this muscle and the adjacent articulations. The internal branch is the continued trunk, accompanies the dorsal artery of the foot to the first interos-

seous space, gives off small muscular filaments to the muscles in that space, which maintain a delicate communication with the external plantar nerve, and ends in two branches which supply the dorsal integument on the opposed sides of the first and second toe. In this course along the foot it gives off subcutaneous and cellular filaments, which communicate with the dorsal cutaneous nerves from the musculo-cutaneous.

The *internal poplitæal*, or *posterior tibial nerve*, is much larger than the preceding; in direction and size it is the continued trunk of the sciatic, and is destined to supply the large muscles on the back of the leg, and the muscles and integuments of the sole of the foot; in the ham it may be named poplitæal, in the leg posterior tibial.

The *poplitæal nerve* descends nearly vertically between the heads of the gastrocnemius and solæus muscles, behind the articulation of the knee and the poplitæus muscle, passes beneath a tendinous arch in the solæus, and becomes the posterior tibial. In this course the poplitæal nerve is covered by the skin and by the strong aponeurosis of this region; is superficial to the artery and vein, and separated from them superiorly by a considerable quantity of fat, but inferiorly is in close contact with them; above, the nerve is to their external side, but as it descends obliquely inwards it gradually crosses them, and inferiorly is inclined to their inner aspect, but still superficial to them. In this course it gives muscular, articular, and cutaneous branches. The *muscular* are very large, and some of them are very long; they arise behind the knee-joint; a large branch divides into two for each portion of the gastrocnemius; these ramify on their deep or anterior surface, and soon enter the interstices between their fasciculi. The plantaris receives a small branch either from the last or from the trunk of the poplitæal. Another large nerve descends between the gastrocnemius and solæus, ramifies on the superficial or posterior surface of the latter, and penetrates its structure; lower down arises the nerve for the poplitæus, this ramifies on its surface, and some filaments bend round its lower border, and are lost on the deep aspect of the muscle. The *articular branches* are usually three in number, superior and inferior internal, and azygos or middle; these accompany the corresponding arteries, and supply the synovial membrane and the other articular tissues. The external articular nerves are derived from the peronæal nerve. The *cutaneous branch* is also named *external saphenous*, or *communicans tibialis*, or *posterior cutaneous nerve of the leg*. It arises as a large branch about the middle of the ham, or sometimes higher, either from the trunk of the poplitæal, or in common with one of the long muscular branches; it descends in the groove between the heads of the gastrocnemii, beneath the fascia, accompanied by a small artery and vein; about the middle of the leg it perforates the fascia, and is joined by the communicans peronæi nerve (this sometimes joins it beneath the fascia); it is here also often joined by a filament from the posterior cutaneous nerve of the thigh, a branch of the sacral plexus. The external saphenous nerve, now subcutaneous, soon meets the external or posterior saphena vein, and descends along with it obliquely outwards to the outer border of the tendo Achillis, and then bends forwards behind the outer malleolus to the external border of the foot and little toe. In this course it gives but few branches to the integuments of the leg; near the heel it sends off several long and large filaments, which descend and expand in the granulated fat on its side and under surface; along the outer border of the foot it supplies the integuments both on the plantar and dorsal surface; the branches to the latter communicate with the external dorsal nerves of the foot from the musculo-cutaneous of the peronæal.

The *posterior tibial nerve*, or continued poplitæal, descends behind the tibia obliquely inwards from the lower margin of the poplitæus muscle to the internal malleolar region; here it becomes flat and thick, and divides into the internal and external plantar nerves. In this course it passes beneath the

tendinous arch at the upper end of the solæus, protected by it from the pressure of the surrounding muscle, then beneath the entire mass of the superficial muscles on the back of the leg, also beneath the strong fascia which separates these from the deep muscles, the tibialis posticus, and flexor communis, on which it rests. Along the inner side of the tendo Achillis it is only covered by the skin and aponeurosis; it accompanies the posterior tibial vessels, being to their inner side above for a short distance, and external to them during the remainder of its course. In the malleolar region it is placed external or posterior to the sheaths of the tibialis posticus and flexor communis, and to the tibial vessels, and anterior to the sheath of the flexor pollicis longus. In this region it is only covered by the skin and by a tense aponeurosis, consisting of two laminæ. This nerve, in the upper part of the leg, sends muscular branches to the tibialis posticus, flexor communis, and flexor pollicis; that to the latter accompanies the fibular artery, and sends small filaments through the interosseous membrane. On the inner side of the tendo Achillis it gives off one or two very large branches, which pierce the fascia and descend to the integument on the internal and inferior surface of the heel and inner side of the sole of the foot.

The *internal plantar nerve* is larger than the external; it passes forwards along the inner side of the tarsus above the abductor pollicis, accompanied by the internal or smaller plantar artery, sends many branches to the plantar muscles and to the integuments, and, arriving near the base of the great toe, divides into four digital branches. The first runs along the tibial side of the first toe; the second subdivides and supplies the opposed sides of the first and second toes; the third, in like manner, the second and third toes; and the fourth the opposed sides of the third and fourth toes; these digital nerves also supply the lumbricales, and give off dorsal cutaneous branches, which communicate with the dorsal nerves of the foot.

The *external plantar nerve* passes forwards and outwads, along with the external plantar artery, above the flexor brevis and beneath the long flexor tendons and their accessory muscle, to the fifth metatarsal bone, and divides into two branches; one, the superficial, supplies both sides of the little toe and the outer side of the fourth; the deep branch passes obliquely inwards, in the form of an arch, across the metatarsus, and supplies the interossei and the other deep plantar muscles.

SECTION III.

DISSECTION OF THE GANGLIONS.

In addition to the five small ganglions on each side, already noticed in the description of the cerebral nerves, viz., the Casserian, the lenticular or ophthalmic, the spheno-palatine or Meckel's, the sub-maxillary, the Otic, or the ganglion of Arnold, also the several ganglions on the posterior roots of the spinal nerves, we find one continued chain of these bodies placed along the vertebral column on either side of the median line, and at regular intervals. These ganglions, on each side, are all connected to each other, and resemble a knotted cord; these cords receive the name of the sympathetic nerves.

The Sympathetic Nerves, therefore, are two in number; they descend from the base of the cranium perpendicularly along the neck, placed anterior to the vertebræ, on the rectus capitis and longus colli muscles, and behind the great vessels and nerves. At the upper end of the chest each of these nerves is divided by the subclavian artery into several branches, which encircle that

vessel and unite below it in the thorax. Through this cavity they descend at first obliquely backwards and outwards along the side of the spine, over the heads of the ribs, and their stellate ligaments, and covered by the pleura; they then incline a little forwards, and pass behind the true ligamentum arcuatum into the abdomen; through this region they descend obliquely outwards on the forepart of the lumbar vertebræ, between the psoæ and the crura of the diaphragm; they then sink into the pelvis, keeping close to the sacrum, and descend along the anterior surface of this bone obliquely inwards; near its inferior extremity, or on the first part of the coccyx, they unite and terminate in a small ganglion, named coccygæal, or impar. The superior extremity of each sympathetic nerve is connected by several filaments to several of the cerebral nerves. Some of these connections, particularly that to the sixth, have been improperly termed the origin of the sympathetic; at the base of the cranium it communicates, either directly or indirectly, with the seventh, eighth, and ninth; in the cavernous sinus and orbital plexus with the third, fourth, fifth, and sixth; and even with the olfactory, optic, and auditory, by the fine filaments which accompany the nutrient arteries of those several organs in which these nerves expand and terminate: it also communicates, as has been already noticed, with the several ganglions in the head. In their course along the spinal column, each nerve regularly communicates with every pair of the spinal nerves, with each of the cervical nerves by one, and sometimes by two filaments, and with each of the dorsal, lumbar, and sacral nerves by two, so that these nerves may be said to communicate with every nerve in the cerebro-spinal system. The sympathetic nerves have been considered by some as independent nervous systems, communicating by numerous branches with every portion of the cerebro-spinal system; by others they are regarded as nervous cords, formed by the union of branches from all the spinal and from several of the cerebral nerves; the latter is probably the more correct view. The doctrine propounded by Bichat has had many supporters. This distinguished anatomist and physiologist maintains that there are two distinct nervous systems, one presiding over volition and all the functions of animal life, the other over all the organic functions and involuntary motions; the cerebro-spinal axis, the cerebral and spinal nerves, constitute the first, the numerous ganglions the second. All these latter bodies he accordingly associates in one group, and describes the lenticular or ophthalmic and spheno-palatine as offsets from the superior cervical ganglion. This arrangement has been adopted by many subsequent anatomical writers. Bichat further contends that there are no such nerves as the sympathetic, and that none such ought to be described; but that, scattered at intervals along the whole length of the spine, are a number of ganglions of irregular and variable form and size: that these are each independent centres of nervous matter and distinct sources of nervous power; that they communicate with all the nerves of animal life, also with one another, and that the latter series of connecting filaments (commonly called sympathetic nerves) are merely communicating branches, and very variable as to size, and even as to existence, and that some of these are occasionally wanting, so as to cause an interruption or want of continuity in the cord in some parts, as between the thorax and abdomen, where the connecting filament is often extremely minute, and according to Bichat, sometimes absent. These views, though very ably and ingeniously maintained (*see* Bichat's Anat. Gen., tom. i. p. 215, *et seq.*), are strongly opposed to the opinions and more accurate researches of modern observers, as also by the excito-motor theory. Two very obvious objections also present themselves to this proposed division of all the nerves into two distinct orders, animal and organic; the first is, that the eighth pair, or pneumogastric, large nerves in the cerebral or animal system, are as much engaged in some of the important functions of organic life as any of the ganglionic

nerves: and the second is, that the thirty or thirty-one pairs of spinal ganglions are excluded from either class; these clearly appertain to the cerebro-spinal system, and yet are associated with the organic ganglions in many instances as distinctly as either the lenticular or spheno-palatine. Indeed Bichat himself admits that the ganglions on the posterior roots of the spinal nerves form an important exception to his arrangement, and one which he is unable to qualify or to explain away (*see* tom. i. p. 232). Without entering further into physiological discussion as to these different views, it appears to me that, in studying the anatomical relations of the ganglionic system, or the sympathetic nerves, it is advisable to regard them as two nervous cords, extending from the head to the coccyx, along the spine, and formed most probably by converging filaments or roots from all the spinal nerves, ganglions existing at the numerous points of junction. I have also considered it advisable for the student to examine the several small ganglions in the head along with those cerebral nerves to which they are principally connected, or more obviously so than they are to the sympathetic. The student may now proceed to examine the sympathetic nerves, their ganglions, and their branches; the structural peculiarities of this nerve shall be noticed after its descriptive anatomy. Although perfect symmetry does not exist between these on the right and left sides, yet the differences are but trifling. The sympathetic nerves send off numerous branches, which are chiefly destined to supply the heart and the coats of the great vessels, and all the pelvic and abdominal viscera, except the stomach. These should be examined distinctly in the four regions in which they exist, the neck, chest, abdomen, and pelvis. These branches arise from the ganglions on these nerves; of these there are generally three in the neck; in the back and loins they correspond with the number of vertebræ in those regions, and in the pelvis there are three on each side, and the coccygæal or impar ganglion below.

The *cervical ganglions* are three, the superior, middle, and inferior. The number, however, is variable, frequently there are only two, occasionally there are four: sometimes the superior is continued along the cord more than half-way down the neck; the number and size often vary on the opposite sides.

The *superior cervical ganglion* is of an oval figure and reddish color, extending from the first to the third cervical vertebræ, placed on the rectus capitis anticus, behind the carotid artery and jugular vein, and internal to the eighth and ninth cerebral nerves; its upper end is very small, and about half an inch beneath the carotid foramen in the petrous bone; its lower is often undefined, but is usually on a level with the lower border of the third cervical vertebra; it is sometimes round and prominent, sometimes prolonged upon the cord, and sometimes bifid. This ganglion sends off several branches, viz., superior, inferior, internal, external, and anterior. The *superior branches* are two in number; they ascend in the carotid canal to the cavernous sinus, and communicate with the sixth and with the vidian branch of the fifth. In the carotid canal they form the internal carotid plexus, which is entangled with fine areolar tissue and capillary vessels, and sometimes presents some ganglionic appearance. From this plexus some filaments pass through the petrous bone into the tympanum, and join the nerve of Jacobson, a branch from the glosso-pharyngeal; it next gives off (or, according to some, receives) the vidian branch to the spheno-palatine; above this, and at the lower part of the cavernous sinus, branches join the sixth nerve; the latter appears flattened and slightly enlarged at the junction. In this sinus the ascending small filaments, two or three in number, again form a plexus, named *cavernous plexus;* this is chiefly on the inner side of the artery, while the sixth nerve is on its outer side. From this plexus filaments pass to the Casserian ganglion, others to the orbital plexus and lenticular ganglion, and the remainder

accompany the artery to the brain, subdivide into extremely minute filaments, which follow the ophthalmic and the other branches of the artery. The *inferior* or *descending branch* is the continued cord of the sympathetic itself, which joins the middle or inferior cervical ganglion, and is very variable as to color and size. The *anterior branches* are numerous; some communicate with the eighth and ninth in the great basilar plexus, others surround the external carotid, and divide into fasciculi, which accompany all its branches, and form loops and plexuses around each, named, from their destinations, thyroid, lingual, &c. Most of these branches are of a gray color, and very soft, and have been named by Scarpa "nervi molles." The *external branches* join the superior cervical nerves; they are large and ganglionic, some join the nervous loop, the principal unite with the second cervical, and others with the third and fourth. By careful dissection these communicating spinal branches may be traced along the spinal nerves into the intervertebral foramina. Their connection with the anterior root of each is very obvious; but I have frequently demonstrated filaments continuing to the ganglions on the posterior roots. Although these uniting branches are here described as arising from the sympathetic, it would probably be more correct to consider them as proceeding from the spinal nerves, to form the cervical roots of the sympathetic. The *internal branches* are pharyngeal, laryngeal, and cardiac. The *pharyngeal* arise from the superior part of the ganglion, are of a pale red color and ganglionic structure; they pass inwards and join the pharyngeal branches of the glosso-pharyngeal and pneumogastric in the extensive plexus which supplies the pharynx and fauces. The *laryngeal branches* arise near the last, pass downwards and inwards, and join the branches of the superior laryngeal nerve. The *superior cardiac*, or superficialis cordis, arises near the lower part of the ganglion, descends obliquely inwards, behind the sheath of the common carotid, along the side of the trachea and œsophagus, crosses in front of the inferior thyroid artery, and becomes nearly parallel to the inferior laryngeal nerve; it then enters the chest, sometimes anterior, sometimes posterior to the subclavian artery; on the right side it follows the innominata, arrives at the back part of the arch of the aorta, and passes obliquely inwards between this and the trachea, and joins the great cardiac ganglion, which shall be considered presently. The superficial cardiac nerve often arises by several filaments, some of which are from the cord below the ganglion, others from the vagus; in its descent also it is often joined by branches from this nerve, and inferiorly from the recurrent; it sometimes passes behind the inferior thyroid artery, or, dividing into two branches, these separate, inclose the artery, and reunite. As it enters the chest it is frequently joined by filaments from the other cardiac nerves and from the inferior cervical ganglion of the sympathetic; before it enters the cardiac ganglion it sends off some filaments to the forepart of the innominata and of the arch of the aorta. The nerve of the left side pursues an analogous course; but these nerves on either side are extremely variable, and the description will seldom exactly accord with the dissection.

The *middle cervical ganglion* is sometimes wanting; it is smaller than the superior, of a triangular, often of an irregular form; is situated behind the carotid near the curve of the inferior thyroid artery, opposite the fifth vertebra, and upon the longus colli muscle; it sends off branches in different directions, externally to communicate with the fourth and fifth cervical nerves, internally with the vagus: from its anterior and internal aspect it sends off the *middle* or *great cardiac nerve*, which descends parallel to the recurrent, communicating with it and with the vagus, and with the superior and inferior cardiac nerves, enters the chest in several branches, which pass around the subclavian artery, and finally join the cardiac ganglion and plexus.

The *inferior cervical ganglion* is of an irregular figure, semilunar or trian-

gular; it frequently appears to consist of several small ganglions, connected to each other by reddish filaments; it is situated between the transverse process of the last cervical vertebra and the neck of the first rib, behind and on either side of the vertebral artery, and between the scalenus and longus colli muscles; filaments from it communicate with the phrenic nerve and with the brachial plexus; several also encircle the subclavian artery, and unite beneath it in the first thoracic or dorsal ganglion; its external branches join the three last cervical and first dorsal nerves; some extend along the subclavian or axillary artery and its branches, and may be traced to a great distance, forming plexuses in their tissue; a considerable fasciculus ascends along the vertebral artery, forms plexuses around this vessel, which, in their ascent, communicate with the cervical nerves through the intertransverse spaces. These may be followed into the cranium; those of opposite sides unite on the basilar artery; they follow its branches, on which they communicate with the analogous filaments from the carotid plexus. From its internal aspect proceed the *inferior cardiac nerve*, or nerves, which communicate with the middle and with branches from the vagus and recurrent, and pass inwards between the aorta and division of the trachea, and end in the cardiac plexus.

The student may next examine the *cardiac nerves, ganglion*, and *plexus*. These nerves are extremely irregular as to origin, size, course, and number. Scarpa has delineated them beautifully, but few dissections will be found exactly to correspond with his representations or descriptions; there are usually three on each side, and are named superior, middle, and inferior. The *superior* cardiac nerve, though very small, takes a long course; it arises by two or three filaments from the inner and forepart of the superior cervical ganglion, but is very variable; descends along the side of the trachea, behind the carotid artery, to the chest. In this course it communicates with the laryngeal nerves, with the vagus, and with the inferior and middle ganglions of the sympathetic: there is sometimes a small ganglion upon it near the inferior thyroid artery; at the lower part of the neck it passes behind the subclavian vein, and over, but sometimes behind, the subclavian artery, or encircling it with its branches, then passes along the lower and posterior aspect of the arteria innominata. It here divides into several filaments; some pass along that vessel to the forepart of the aorta, others join the recurrent nerve and the middle and inferior cardiac nerves. The superior cardiac nerve on the left side has a similar origin and course in the neck, but it enters the chest in a deeper situation than the nerve of the right side; it descends between the left carotid and subclavian arteries, and, arriving at the arch of the aorta, divides into branches, some of which pass behind that vessel and join the cardiac ganglion; others unite with the cardiac nerves from the sympathetic, or from the vagus and recurrent. The *middle* cardiac nerve on the right side is generally the largest of the cardiac nerves: on the left side it is sometimes wanting; the inferior in such a case will be of a greater size: it arises by several filaments from the middle cervical ganglion, or from the sympathetic nerve about the middle of the neck; it descends, either a single cord, or divided into several parallel filaments, behind and internal to the carotid, and enters the thorax anterior to or encircling the subclavian artery. It here is joined by large branches from the vagus and recurrent nerves; it then descends obliquely inwards along the side of the arteria innominata, glides between the arch of the aorta and the division of the trachea, and terminates in the cardiac ganglion or plexus. On the left side the middle cardiac nerve sometimes arises from the inferior cervical ganglion; it enters the chest along the subclavian artery, and either joins the inferior cardiac nerve, or enters the cardiac plexus. The *inferior* cardiac nerve, or nerves proceed from the inferior cervical ganglion, and on the right side descend behind the arteria innominata to the arch of the aorta, round which some pass to its forepart; the others terminate principally

in the anterior cardiac plexus. Some branches pass between the aorta and pulmonary artery to the cardiac ganglion; the inferior cardiac nerves communicate with the preceding, also with the vagus, and especially with its recurrent; they form an irregular network or plexus in their course to the aorta. On the left side these nerves accompany the subclavian artery, and partly join the middle cardiac nerve, and partly the cardiac plexus. Thus the cardiac nerves of one side communicate freely with each other on the sides and forepart of the trachea, and with those of the other side in the concavity of the arch of the aorta, both below and above the right or transverse branch of the pulmonary artery.

The *cardiac ganglion* is situated within the arch of the aorta, on the right side of the ductus arteriosus; it is joined by the right and left superior cardiac nerves, and by branches from the pneumogastric. Its size and structure are very variable; instead of a single distinct ganglion, it often appears as a congeries of small ganglions entangled in the plexus of the uniting nerves.

The *great cardiac plexus* is exposed by dividing the aorta and pulmonary arteries above their roots; it is situated behind the ascending aorta, near its origin, and in front of the division of the trachea, and above the right pulmonary artery; it consists of a plexus of nerves formed by the middle and inferior cardiac nerves from opposite sides, also by branches from the eighth pair and the recurrent nerves. In the meshes of this plexus several small ganglions are inclosed; the roots of the large vessels and the structure of the heart are supplied by branches from the great cardiac ganglion and plexus, and from the cardiac nerves. These branches form two smaller plexuses, named the anterior or superficial, and the posterior or deep.

The *superficial* or *anterior cardiac*, or *coronary plexus*, is placed on the forepart and right side of the aorta near its root; it is formed partly by filaments from the superior cardiac nerve, and from the cardiac ganglion and plexus; the latter come from beneath the arch, between it and the right auricle. Many of the former can be seen, without dissection, upon the convexity of the aorta, through the serous membrane; the branches spread over the anterior surface of the heart; some accompany the left coronary artery, but the greater number surround the right or anterior coronary, and form a plexus around it, and the filaments accompany the branches of this vessel, and supply the right auricle and ventricle. The *posterior plexus* is formed of branches from the great cardiac plexus and left inferior cardiac nerve; it is behind the root of the aorta and between this vessel and the pulmonary artery, and above the auricular sinuses; its branches principally accompany the left coronary artery, form a plexus around it, and follow its ramifications through the tissue of the left ventricle; other branches pass into the auriculo-ventricular sulcus towards the right side, and join the anterior plexus. The coronary plexuses, so named from their attachment to the coronary arteries, supply both auricles and ventricles; the branches to the latter are larger and more numerous; at first they are distinguished with some difficulty from the vessels and from the serous tunic. If the heart be immersed for some time in boiling water, or allowed to remain a few days in strong spirits, the nerves can be easily exposed; they are extremely minute, but very long, and can be traced at first parallel to the muscular fasciculi, then crossing them, and subdividing into their ultimate fibrillæ.

The sympathetic nerves in the thorax have twelve ganglions on each side of the spine, sometimes only eleven, the last cervical and first dorsal being then united. Each of the *thoracic ganglions* is small, flat, and triangular, the base towards the spine, the apex externally, covered by the pleura and a thin fascia; they are placed on the heads of the ribs, in front of the intercostal vessels; the first, second, and last are the largest; they all communicate by

their external branches with the anterior or intercostal branches of the spinal nerves. These branches are two in number, white and fibrous; they in general ascend obliquely to join the spinal nerves, which they resemble in structure, and ought properly to be considered as the dorsal roots of the sympathetic. From the base or anterior edge of each ganglion arise the *internal* branches, the mediastinal and the great and lesser splanchnic. The mediastinal or aortic branches pass forwards into the posterior mediastinum, ramify on the aorta and its intercostal branches and the adjacent vessels, and communicate with the pulmonary plexus: those from the right side are longer, as they have to cross the spine. From the six inferior ganglions the splanchnic nerves arise; these are two in number on each side, the greater and lesser, or upper and lower.

The *great splanchnic nerve* arises by four or five distinct roots from the sixth, seventh, eighth, ninth, and tenth ganglions; they descend obliquely forwards, and unite on the tenth dorsal vertebra into one large, flat cord, which enters the abdomen either along with the aorta or separated from it by a fasciculus of the diaphragm; each nerve then expands into the semilunar ganglion. The great splanchnic nerves are very variable as to their number of roots, there being sometimes only two, sometimes five or six; that from the sixth ganglion is the largest. This nerve is white and fibrous, and more like the spinal than the sympathetic; careful dissection can loosen and detach it in a great degree from the ganglions, and show its real origin to be from the spinal system.

The *lesser splanchnic nerve* arises by two roots, from the tenth and eleventh ganglions; these unite on the side of the last dorsal vertebra. This small nerve then enters the abdomen through the crus of the diaphragm external to the great splanchnic nerve, with which it communicates, and then ends in the renal plexus; it sometimes escapes along with the great splanchnic. There are sometimes two nerves answering this description, one of which will join the first lumbar ganglion, and may thus maintain the communication between the thoracic and lumbar portions of the sympathetic. Before we trace the latter we shall follow the great splanchnic nerves, which form the chief supply of nerves to the abdominal viscera.

The *semilunar ganglion* of each side is situated on the diaphragm, and partly on the aorta, on either side of the cœliac axis, and above and behind the suprarenal capsule. These are the largest ganglions on the sympathetic; though called semilunar, their form is very variable and irregular, and frequently, instead of a single mass, they consist of a congeries of knotted ganglions on the nervous cord; the right and left communicate with each other by several filaments, on which again small ganglions are placed. This communication surrounds the cœliac axis, and, as branches radiate from it in all directions, it is termed the *solar plexus*. This plexus is situated in the epigastrium, behind the stomach, in front of the aorta, and above the pancreas. In this plexus there are also some filaments from the lesser splanchnic and phrenic nerves, and the right vagus terminates in it; it is the most highly developed portion of the sympathetics, and has been regarded as the head or centre of the great organic nervous system by some, who maintain the independence of the ganglionic system and its distinctness from the cerebro-spinal nerves. From it numerous nerves pass off in various directions; these nerves accompany the bloodvessels, and form plexuses around each, which are named, according to their destination, *hepatic*, *splanchnic*, *gastric*, &c.

1st. The *phrenic plexuses* consist of branches arising on each side from the upper part of the solar plexus, accompany the phrenic arteries, and enter the diaphragm beneath the peritoneum; some branches follow the phrenic vessels, others pass in different directions, and join some minute filaments from the phrenic nerves of the cervical plexus.

2nd. The *suprarenal plexuses* arise partly from the last, and, by some delicate filaments from the semilunar ganglion of each side, they twine around the arteries which conduct them into the suprarenal bodies.

3rd. The *coronary* or *gastric plexus.*—This fasciculus arises from the upper and anterior part of the solar and from the right vagus, accompanies the arteria coronaria ventriculi. along the lesser curvature of the stomach, to the lesser omentum ; its filaments are lost in the submucous tissue, and communicate with those of the right and left vagi.

4th. The *hepatic plexus* is a very large fasciculus, arising partly from the solar and partly from the semilunar ganglions ; its large posterior filaments accompany the vena porta, and its anterior the hepatic artery ; these nerves accompany the vessels in the lesser omentum to the liver ; some are very large and distinct, they enter the transverse fissure, and ramify along with the vessels through the capsule of Glisson. While in the lesser omentum they send long filaments to form the right gastro-epiploic plexus along the great border of the stomach ; others also along the cystic artery to the gall bladder.

5th. The *splenic plexus* proceeds in a similar manner around the splenic artery : it is not so large as the hepatic ; it sends many filaments to the pancreas, to the great end of the stomach, and along the left epiploic artery, to its great curvature : the remaining few filaments enter the spleen.

6th. The *superior mesenteric plexus* is a very broad and thick fasciculus, continued from the lower border of the solar ; it forms a complete sheath for the superior mesenteric artery ; its branches are numerous, very long, and distinct ; they accompany the arteries, but are straight, and do not form the same number of arches as the vessels are remarkable for : near the intestine many of them usually unite in an arch, from which fine filaments enter the tissues of the intestines. This plexus supplies all the small intestines, the cæcum, ascending colon, and right portion of its transverse arch.

7th. The *renal plexuses* are formed by branches from each side of the solar, joined by the lesser splanchnic nerves ; they surround the renal arteries, and accompany them into the kidneys. In the male each renal plexus gives off a fasciculus to accompany the spermatic artery, around which it forms the *spermatic plexus*, and descends to the testis ; in its course along the psoas it gives off filaments to the ureter. In the female corresponding branches from the renal plexuses supply each ovary.

8th. The *inferior mesenteric plexus* is much smaller than the superior, from the root of which it is principally derived, being also joined by branches from the lumbar ganglions of the sympathetic ; it accompanies the inferior mesenteric artery and its branches, and supplies the left portion of the arch, the descending and the sigmoid flexure of the colon.

9th. The *hæmorrhoidal plexus* is formed by the filaments of the inferior mesenteric, continued around the superior hemorrhoidal arteries, joined by small branches from the lower lumbar ganglions ; it supplies the superior and middle portions of the rectum, and communicates with the hypogastric plexus.

From the sympathetic cords in the thorax a small branch is continued obliquely downwards and forwards on each side, close to the spine, and behind the crus of the diaphragm, to join the first lumbar or abdominal ganglion. This branch is seldom absent ; when it is, the inferior splanchnic nerve, after joining the renal plexus, enters this ganglion, so that the continuity is always maintained between the thoracic and abdominal portions of the sympathetic nerves. The *lumbar ganglions*, and their connecting thread, are placed on the anterior aspect of the lumbar vertebræ, in a tendinous groove, between the crus of the diaphragm and psoas magnus of either side, nearer the median line above, but diverging below ; they are variable in number, usually four,

and sometimes only three, and often one is prolonged into another. The *external branches* of each are two, *communicating;* they accompany the lumbar arteries, beneath the psoas muscle, close to the grooves on the sides of the vertebræ, and join the anterior lumbar nerves in the intervertebral foramina; they are white and distinct, and may be regarded as the lumbar roots of the sympathetic. These branches frequently have ganglions upon them, and they often unite with filaments from the lumbar plexus.

The *anterior* and *internal branches* are aortic and splanchnic. The aortic branches are numerous, they pass forwards in front of the aorta, the nerves of opposite sides unite, and are joined by branches from the solar plexus, and form a plexus, *lumbo-aortic.* This surrounds the aorta between the superior and inferior mesenteric arteries; small arteries, and lymphatic glands and vessels are entangled in it; some of its branches join the inferior mesenteric plexus; inferiorly it divides into three portions; the middle enters the pelvis, and joins the hypogastric plexus; the lateral accompany the common iliac arteries to their division, and several filaments are prolonged around the internal and external iliac vessels. The *splanchnic branches* pass forwards from each ganglion, and join the several abdominal plexuses already mentioned.

The *hypogastric plexus* is of considerable extent; it is formed by the continuation of the lumbo-aortic plexus, joined by filaments from the lumbar ganglions; is situated in front of the base of the sacrum, between the common iliac arteries, and divides into a *right* and *left hypogastric plexus;* each of these is joined by branches from the sacral ganglions and anterior sacral spinal nerves; each plexus sends off numerous branches, which again form secondary plexuses on the organs to which they are distributed. Thus we have hæmorrhoidal, vescical, prostatic, ovarian, and uterine plexuses. All these plexuses contain filaments from the sacral nerves as well as from the sympathetic, and all are conducted to their termination by the arteries of each organ.

As the sympathetic cords descend obliquely inwards, over the base of the sacrum, behind the iliac vessels, they are extremely small; in the pelvis they at first increase in size, descend converging, and each ends in a minute thread; they are placed near the inner margin of the anterior sacral foramina. The *sacral ganglions* are four or five in number, of an oval or round form; their *external branches* join the anterior sacral nerves; their *internal branches* join the hypogastric, or some of their secondary plexuses. From the last ganglion a small branch arches across to meet a similar one from the opposite side; on this a small ganglion (*impar*) is occasionally to be found; if absent, a connecting plexus occupies its place: the terminal filaments are very minute, and distributed to the forepart of the os coccyx.

Although the sympathetic nerves and their branches appear to differ in structure from that of the cerebro-spinal nerves, yet they are essentially the same; the fibres seldom appear so white, but have rather a grayish, red color. The general neurilemma of each nerve is more dense, and, therefore, the internal fibrous or fasciculated texture is not so obvious; but, if the former be carefully divided, the latter will be found equally apparent. The great distinction depends on the occurrence of numerous ganglions, both on the principal cords as well as on their branches; each ganglion is invested with a firm capsule, which is continuous with the sheath of the afferent and efferent nerves. This capsule is surrounded by areolar tissue and bloodvessels; the latter ramify on and pierce the capsule; the internal surface of the latter is very vascular, and may on the larger ganglions be separated as a vascular membrane from the external fibrous layer, and is analogous to the pia mater on the cerebro-spinal axis. The mass of a ganglion is composed of a plexus of nervous filaments, with a variable quantity of vesicular or gray neurine; the afferent nerves divide into numerous fibrillæ, which pass in the most varied directions, and reunite most probably in different combinations, the interstices

being filled with capillary vessels and gray neurine. Whether the efferent nerves consist of those filaments only which composed the afferent, or whether additional fibres are added to these in the ganglion, it is difficult and, in the present state of our knowledge, impossible to determine. The only material difference to be observed between the structure of the ganglions of the sympathetic and those of the cerebro-spinal system is, that the latter appear in general to be less red and vascular, and to contain less of the vescicular or gray neurine; the interlacement of white fibres is more obvious in them, and constitutes the greater portion of each, particularly of the spinal ganglions.

CHAPTER IV.

ORGANS OF SENSE.

The organs of the senses establish certain relations between man and the external world, and are the instruments, or media, whereby he obtains all his knowledge of the physical characters and of the general and particular properties of all surrounding objects. They are generally considered as five in number, viz., the nose, or the organ of smell; the tongue, or the organ of taste; the eye, or the organ of vision; and the ear, or the organ of hearing. To these may be added the integuments, or the organ of touch. Each organ of sense is placed near the surface of the body, is furnished with an appropriate apparatus suited to its peculiar function, and is in direct connection with the nervous centre. The four first-mentioned organs are connected to particular portions of the brain, each by its proper or peculiar nerve; but the sense of touch being disseminated over the whole surface of the body, and its apparatus being supplied by the posterior or ganglionic roots of the fifth cerebral and of all the spinal nerves, is therefore connected to the cerebro-spinal axis generally.

SECTION I.

ANATOMY OF THE SKIN, OR ORGAN OF TOUCH.

As the *sense of touch* is diffused over the whole surface of the body, and is uniformly present, though in very different degrees in the different classes of the animal kingdom, and as the apparatus for its development is more simple than that for the other senses, we shall consider it first. This sense resides essentially in the skin, but it also exists more or less in the mucous surfaces, particularly near their outlets, as in the mouth, anus, and urethra; also in the conjunctiva or mucous membrane of the eye, and in that of the nose, fauces, and larynx: indeed, as the skin and mucous membranes are continuous, so are they closely allied in function and in structure, and both may be regarded as one extensive membraneous expansion, investing the whole external surface of the body, and lining all the hollow viscera of the respiratory, digestive, urinary, and generative apparatuses, and also prolonged into all the follicles, excretory ducts, and their tubular ramifications through the secreting glands. This extended membrane, though differently modified in different portions of its extent to suit particular purposes, is yet analogous in structure throughout, and is essentially composed of the same elements,

namely, of two laminæ; one is external or superficial, and named cuticle, or epidermis, or epithelium; the other is deeper, and is named the cutis vera, dermis, or chorion. Beneath the latter is added more or less of areolar, or cellular, and adipose tissue, which serve to support and conduct the numerous vessels and nerves that supply this highly organized structure.

The sensibility of the skin renders the individual not only sensible to the contact and pressure of external objects, but also enables him to appreciate many of their physical qualities, such as their temperature, size, form, consistence, and weight; all parts of the skin, and indeed most structures in the body, possess a certain degree of sensibility to temperature and to contact, that is, they possess *touch* generally; but the power of discerning the other qualities of bodies is developed only in certain situations, where there is a corresponding refinement of organization and development of sentient papillæ, which are enabled to take cognizance of these qualities with a wonderful degree of nicety and perfection. This power is by some denominated the sense of *tact*, and resides especially in the integument of the fingers and toes.

The skin also effects other important purposes in the animal economy; it forms a perfect covering for the body, which is strong, dense, and resisting, but flexible, yielding, and elastic, and, while its external lamina is sufficiently thin to allow impressions to be conveyed to the deeper sentient surface, it is itself an insensible protecting investment. The skin is also the seat of an important secretion, which serves to purify or aerate the blood in a manner somewhat analogous to respiration: this secretion is discharged in the form of a fine halitus or vapor, named the "insensible perspiration;" but when the circulation is increased in activity, or when the body is exposed to a high degree of temperature, it is given forth in the form of minute drops, which appear like dew upon the surface, and is then called "sensible perspiration," or "sweat." This exhalation carries off from the blood a large quantity of water, carbonic acid, saline, and various animal or azotized matters, which are effete or injurious to the system. The importance of this cutaneous exhalation is well known both in health and in disease, and is influenced by the general state of the body, of the mucous surfaces, and of the vascular and nervous systems, and is also in some measure vicarious with the renal secretion. The skin is also the seat of a sebaceous or oily secretion, which preserves it in a soft and pliant state, repels external moisture, and defends it from the drying influence of the air. The cutaneous exhalation and secretion also exert a useful influence in regulating animal heat; the constant evaporation upon the surface, which is proportioned to the surrounding temperature, must affect that of the skin and of its fluids in a corresponding ratio; and as the perspiration is increased in warm weather, or in hot climates, and under increased activity of the healthy circulating organs, the cooling effect of its evaporation becomes more powerful and useful. The skin is also an inhalent and absorbent surface; its numerous lymphatics, arranged in a plexiform manner, would alone indicate this fact, which, however, has been proved by several experiments. Thus, immersion of the body has been found to increase the general weight, to relieve thirst, and even to supply nutrition, and certain colored infusions, applied to the surface, have been subsequently detected in the urine.

To fulfil these several intentions, the integument must possess a complex structure and a high degree of organization; accordingly we find that, in addition to its three essential elements, namely, the protecting epidermoid lamina, the true chorion, and the areolated fibrous tissue, it also contains numerous glands and follicles, the sources of the perspiration and sebaceous secretion; it is also the seat of a most extensive and minute capillary network of arteries, veins, lymphatics, and nerves. The latter are principally derived from the cerebro-spinal system; and so universally distributed are

the vessels and nerves, that the smallest spot upon the surface cannot be punctured with the finest-pointed instrument without more or less discharge of blood ensuing, and pain being felt, instant and acute. The skin is also furnished with certain appendages, the hairs and nails; the former serve as a partial covering and protection; the latter as means of defence and offence, and a support in those particular situations where the tactile papillæ reside. We shall now proceed to examine these several tissues.

The *external surface* of the skin presents varying shades of color in different situations, which partly depend on the different density and vascularity of each, and partly on a peculiar coloring matter found beneath, or rather entangled in the deeper layers of the epidermis. On the greater or lesser development and peculiar tint of this pigment depend the various shades of color in the different races of mankind. This surface of the skin also presents numerous folds or wrinkles, lines and furrows; thus, over many of the joints, and principally on the aspect of extension, there are permanent folds to admit of free motion and flexion without any stretching of the skin, as on the knuckles, elbows, and knees. Almost the entire surface presents small folds, of an irregular form, inclosing areolar spaces; these are to admit of the easy extension and motion of the skin in every direction; in particular situations also there are certain folds depending on the contraction of muscles, and are permanent in some cases, transient in others. Between all these cutaneous folds, or elevations, there are numerous depressed lines running in the most irregular order; on the plantar and palmar regions, particularly on the pulpy extremities of the fingers and toes, there are numerous fine ridges and intervening depressions, arranged in concentric arches, convex towards the tips; these correspond to the sentient papillæ on the cutis. This surface also presents numerous minute pores; some are the orifices of the various ducts and follicles, others are for the passage of hairs. The integument is more dense, but less vascular and sensible on the posterior part of the body and of the limbs than on the anterior aspect; it is thin and very highly organized on the face and neck. In the plantar and palmar regions the cuticle is infinitely thicker than in any other situation, but the cutis is very vascular and sensible.

The *deep surface* of the skin is an areolar structure, which serves to connect it to the subjacent parts, and contains the glands, hair bulbs, and the vessels and nerves in their course to the cutis. The density and structure of this subdermoid tissue differ in different situations, in some being very fine, reticular, soft, and moist, where free motion is required, as in the eyelids; in others it is loaded with more or less adipose substance, where it is designed to support much pressure, as on the nates and on the hands and feet; in some situations it is very dense and fibrous, where it is connected intimately and almost immovably to the subjacent structures; in some situations also, as on the face and neck, muscular fibres are inserted into the skin as they are into the mucous chorion generally. In many animals a cutaneous muscular investment, "panniculus carnosus," exists, by which the skin can be corrugated and moved with ease and freedom, so as to shake off any irritating matter. In man, although the skin, except on the face and neck, is deprived of this appendage, it yet possesses some involuntary contractile power, as is seen under certain mental emotions, or on sudden exposure to cold.

To examine the structure of the skin, small portions of it may be removed from different parts of the body, from the back and chest, and from the palm of the hand and sole of the foot. The most careful dissection cannot detach the cuticle from the cutis, although during life the separation is easily effected, either by the application of a blister to the surface for a few hours, which causes an effusion of serum between them, or almost immediately, by moist or dry heat, which produces the same effect; and in the dead body it may be caused either by long maceration in cold water, by putrefaction, or by im-

mersion for a short time in boiling water; but dry heat will not produce the same effect as during life.

The *cuticle* or *epidermis* appears to be a thin, semi-transparent, gray lamina, hard, dry, horny, and homogeneous; when minutely examined, however, particularly during its separation from the cutis, its deep surface will be found to be soft and moist, and numerous fine filaments may be seen to pass between it and the cutis; these can also be well seen in a portion of detached cuticle when floated in water; they are most probably the elongated and ruptured extremities of the fine, exhalent, and sebaceous ducts, also the sheaths of the fine hairs that cover almost the entire surface. All these delicate, cuticular processes, whose direction is mostly oblique, serve to connect the cuticle to the cutis in the most intimate manner. These must be stretched and torn when vesication occurs, and they are thereby closed, so that the fluid is retained. The deep surface of the cuticle is also very uneven, as it is accurately moulded on all the irregularities of the cutis, covering all the ridges or papillæ, and lining all the depressions on its surface. In some animals, where the papillæ project much in a conical or tubercular form, these cuticular sheaths are very obvious. In the plantar and palmar integuments in man, also, these filaments are numerous and distinct, although there are no hairs in those situations. In addition to the lines and furrows already noticed on the external surface of the epidermis, it also presents between these, numerous small pores, which are not visible to the naked eye; in some situations, however, as between the linear papillæ on the fingers and toes, also on the forehead and face, these can be discerned with the assistance of a lens, particularly during increased perspiration. In some animals, especially in fish, excretory ducts are distinct and obvious on the anterior part of the body, and a glairy mucus can be pressed out of them.

The epidermis is composed of small, hard, dry laminæ, in each of which may be observed one or two opaque spots, the original nuclei and nucleoli of the cells, now flattened into scales, of a polygonal and irregular form, overlapping each other at their edges, and adhering to subjacent softer scales; as those on the surface become more dry and thin, they desquamate and pass off as particles of dust, or bran-like scales; this desquamation is often very evident in inflammatory affections of the skin, in which the cuticular scales, or cells, are rapidly formed, and as rapidly shed; it is also well exemplified on the surface of different animals, particularly certain reptiles, and on the wings of some insects; the deeper structure of the cuticle consists of softer scales, or rather flattened cells, and that portion in immediate contact with the cutis is still softer, and is almost a semifluid stratum, containing cells and nuclei. The cuticle is not itself organized, that is, it does not possess vessels or nerves; superficial injuries, so long as they are confined to it, cause no hæmorrhage or pain. It is formed by the vascular surface of the cutis, and the process is supposed to occur in the following manner: from the capillaries of the cutis, fluid lymph, or blastema (βλαστανω, *germino*), constantly exudes; in this are numerous cytoblasts, or cell-germs; these gradually enlarge into cells, which lie closely pressed together, and cover every portion of the papillary surface of the cutis; as soon as the first layer is completed a new layer is formed beneath it in the same manner, and the layer first secreted is separated from the true skin, changes its form and consistence, becomes hard and flat, then by evaporation dry and firm, and after some time desquamates; this is succeeded by fresh ones from below or from within, and thus the processes of waste and supply constantly keep pace with one another; in some situations the cuticle can be separated into different laminæ, in which these successive changes can be observed, and the whole thickness is found to be composed of several strata of nucleated cells in different stages of development, from the external, dry, desquamating scale, to the internal,

or deep, soft blastema, containing the cell-germs. The superficial scales adhere by their edges; the middle laminæ of cells are flattened, and adhere by their surfaces; and the deepest set are soft, connected together, and supported by the semifluid blastema in which they are formed. This varied structure and consistence of the epidermis causes it to form an exactly fitting mould and covering to the uneven papillary surface of the cutis; hence the internal surface of the cuticle presents corresponding irregularities, while the external surface is rendered smooth and even by the condensation of the scales; some papillæ, however, are so prominent, as on the fingers and toes, as to cause slight, permanent, cuticular projections. Among the deeper cells, and in the connecting lymph, granules of colored matter are contained. On the amount and tint of these, the complexion of the skin depends. In the negro and other dark-colored races, this coloring matter appears as a layer of pigment; it is not, however, a distinct or organized membrane, but merely coloring matter deposited in the interstices of the cells; as the latter approach the surface, any coloring matter they carry along with them is lost as they become dry and hard, partly by evaporation, and partly, in all probability, by undergoing some chemical change. Although the epidermis forms one uniform investment for the body, it presents different density on different parts; on the scalp, eyelids, lips, and face generally, it is thin and delicate; but on the palm of the hand and sole of the foot, and in other situations subjected to pressure, it becomes extremely thick and hard; this increase in density appears in many cases to be the result of long-continued pressure and friction, as in the hands and feet of the laboring poor, and may probably be caused by increased action of the vessels of the cutis excited by pressure and exercise; in the plantar and palmar regions, however, even in the fœtus, the cuticle is more dense than in other situations.

It has been already observed that a scaly epithelium exists in other situations as well as on the surface; thus it lines all the bloodvessels and the serous membranes, from which it can be easily detached, and, when examined by the microscope, the nucleated scales appear of a polygonal form; the same scaly structure also exists on the surface of the tongue, mouth, and throat, vagina, and anterior portion of the urethra; but on the more internal mucous surfaces, the epithelial scales assume the columnar form, that is, the cells are elongated like short columns, perpendicular to the surface.

The cuticle, being itself insensible and extravascular, forms a most useful protecting investment for the body, and defends a highly sensitive surface from pressure and friction, and from the stimulating effects even of the atmosphere; while by accurately and closely fitting on all the sentient papillæ, it transmits every external impression with rapidity; the cuticle also, together with the sebaceous secretion, which forms a sort of varnish upon it, is well adapted for repelling external moisture, which accordingly takes no effect upon it, unless very long applied, as in the case of poultice, when it is found to thicken it, and render it opaque, white, and laminated: the cuticle possesses but little hygometrical property, and therefore resists the permeation of fluids; hence it can retain for a long time the fluid of a blister, and is of invaluable service in keeping the cutis soft and pliant, and preventing the evaporation of its fluids; and if it be removed, even in the dead body, the surface of the cutis very soon becomes dry and stiff, and in the living body, the motion of the denuded part is impaired and highly painful.

Dermis, or *chorion*, or *cutis vera*, is composed essentially of areolar tissue condensed into a firm, compact membrane, in which is interwoven more or less of the yellow, elastic, fibrous tissue, with numerous nerves and vessels. Its deep surface is loose, open, and cellular, connected and continuous with the areolar tissue of the subjacent parts, without any exact limit or distinction, only more loose and free in the latter, more close and compact in the former;

the subdermoid cellular tissue contains the cutaneous glands and hair bulbs, and the vascular and nervous ramifications which are to supply the dermis, also more or less of adipose tissue, which not only forms a soft, yielding, and elastic support to the skin, but also adds to the general symmetry of the figure, by filling up the muscular interstices, and smoothing or levelling the general outline of the surface. The subcutaneous adeps differs in quantity, color, and consistence, not only in different individuals, but also according to sex and age; generally it is softer and more abundant in the female; in the child, it is usually at its maximum; in the fœtus, it is peculiarly firm and white; in the adult, it is softer and yellower; and in the aged, it is pale, scanty, and often nearly absent. In the dermis, the areolar tissue becomes condensed and interwoven into a smooth, membraneous surface, which is exquisitely vascular and sensible, and presents beneath the epidermis numerous minute, elevated lines, which are called papillæ; this surface is often spoken of as a distinct lamina of the cutis, under the name of the *papillary membrane*, or surface; it is not, however, to be understood as a separate structure. Immediately beneath this papillary surface is found some yellow, elastic tissue intermingled with the condensed, white, fibrous structure; the fibres of the former are rather horizontal or parallel to the surface, branching and crossing each other, and interwoven with the white, fibrous basis; these two elements can be partially separated and distinguished by long maceration, or by immersion in acetic acid; in either case, the white, fibrous constituent is softened, while the yellow, being little affected, can be partially isolated from the other; by thus treating portions of the integuments removed from different regions, we may contrast the structure, and we shall find that in some places the elastic, and in others, the white tissue, predominates; thus if we compare a portion of the skin and areolar tissue of the axilla, or of the lower part of the abdomen, with that of the plantar or palmar region, we shall find the yellow, elastic tissue to abound in the former, where free motion and elasticity are required, whereas in the latter, the white, fibrous tissue is in the greatest quantity, its tough, ligamentous fibres, with intervening adipose granules, passing deep to join the subjacent aponeurosis, and thereby imparting density and resistance in situations exposed to pressure or violence. The subdermoid areolar tissue also varies in its character in different situations; on the posterior aspect of the trunk, and on the outer side of the limbs, it is more dense, and less vascular and sensitive, than in front; it is soft, fine, delicate, and free from adeps in those situations where rapid motion is required, as in the eyelids.

In the subdermoid tissue, in some situations, reddish fibres are very evident, irregular and wavy in their course; they are seen in the scrotum, labia, penis, and nipples; they are contractile during life, and in structure resemble the involuntary muscular fibre: on the existence of these fibres the contractile property of the skin, so evident in these particular parts, depends; and it is not improbable that the same structure exists more generally, but in a less degree, which may account for the general contractile power occasionally exhibited in the skin, either under certain mental emotions, or from sudden exposure to cold. The cutis abounds in the animal principle named gelatine; this is chiefly derived from the white fibrous tissue.

The *superficial*, or *papillary lamina* of the cutis, is the seat of a vascular capillary plexus, and in the living body appears uniformly red, when the cuticle has been detached; in the dead body it can be so minutely injected that it assumes the color of the fluid. With a lens, the network arrangement of the vessels can be discerned; and if a portion thus injected be extended, dried and then suspended in spirits of turpentine, the vascularity may be well displayed. This surface is studded over with minute elevations or papillæ, which are larger, more numerous, and more distinct in some situations than in others;

on the posterior aspect of the back and limbs, though the cutis is dense, the papillæ are small and indistinct; and accordingly, although general sensation exists there, yet there is but little of the discriminating power of touch, whereas on the palmar and plantar surface of the fingers and toes, and of the hand and foot generally, the true sentient or tactile papillæ are highly developed. On the fingers the skin presents, as before mentioned, numerous curved or arched grooves and ridges; each ridge consists of a row of conical papillæ, and into the intervening grooves the epidermis sinks, and in these the small exhalent pores open. In the separation of the cuticle after maceration, the numerous points of connection between it and the cutis can be perceived, and the fine excretory ducts are seen to admit of some distension before they break or give way. The exact structure of the papillæ themselves cannot be fully ascertained; each appears to be an eminence or projection of the superficial lamina of the cutis, with some portion of the fibro-cellular tissue containing bloodvessels, and most probably nerves. The vessels appear as convoluted loops, and constitute the greater portion of the papillæ; nerves can be traced through the cutis to each papilla, and although the functions of the latter may lead to the inference that they enter its structure, yet they become so soft and fine that it cannot be determined how far they extend, or whether they terminate in loops, or plexuses, or in soft bulbs.

There can be no doubt that in these papillæ exquisite sensibility resides, and that they are the true organs of the *sense of touch* or *tact*; and the same organs, being diffused generally over most parts of the surface, but in a less highly developed state, possess this sense in an inferior degree, while all parts of the skin are sensible to mere contact, and to heat and cold. The voluntary muscles also possess this latter property, and the mucous surfaces, as far as we are acquainted with them; indeed some portions of the latter in an eminent degree, as the membrane of the eyelids, nose, mouth, fauces and larynx, all of which are supplied with nerves from the ganglionic branches of the fifth and eighth cerebral. The lining membrane of the rectum, urethra, and vagina, are all sensible to touch, as well as to heat and cold, which nervous endowment they most probably derive from filaments of the ganglionic or posterior roots of the spinal nerves; and in like manner the voluntary muscles and the skin generally are supplied from the same source. The mucous lining of the trachea and lungs, and of the stomach, is sensible to heat and cold; and the former is highly excited by contact with any foreign body, even with noxious air; all this surface receives its nervous supply from the eighth pair of cerebral nerves. How far the abdominal mucous membrane, beyond the stomach, enjoys sensibility to contact, or even to temperature, is uncertain; most probably it presents it only in a very faint degree, but sufficient to excite reflex motion. This observation would lead to the question, are the branches of the sympathetic nerve sentient, that is, cerebro-sentient, or sensiferous? The functions of the alimentary canal, which receives its nerves from this source, and its not possessing the sense of touch, at least not conveying sensation to the sensorium, would induce us to give the negative answer.

The excreting apparatus of the skin consists of glands and follicles, some of which supply the perspiration or sweat, others the sebaceous secretion. The *sudoriferous* or *sweat glands* exist in all parts of the skin, and are simple follicular bodies, soft and round, imbedded in the dermis, or subdermoid tissue. In the axilla they are large and very distinct, surrounded by capillaries, and their reddish color distinguish them from the adjacent fatty grains; they are composed of a convoluted tube, which ends cæcally by one extremity in the gland, the other becomes the fine exhalent duct which passes in an oblique or spiral course through the cutis and cuticle, and opens by a minute pore; it is lined by a fine epithelium involuted from or continuous with the cuticle. This system of glands must present an extensive secreting surface, capable of

eliminating from the blood a prodigious quantity of fluid and effete animal matter.

The *sebaceous glands*, though not so numerous as the last, are very generally diffused through all parts of the skin, except the palms of the hands and soles of the feet. They are very distinct in the auditory meatus (glandes ceruminosæ), on the inner aspect of the eyelids (glandes Meibomianæ), also on the scalp, face, and tip of the nose, around the nipples, and about the anus, scrotum, and corona glandis (glandes odoriferæ); they are small, round bodies imbedded in the dermis; some are simple, soft, convoluted tubes, others are firm and lobulated; their ducts perforate the skin in a straight line; some are spiral and oblique, and are lined by the involuted cuticle; in the scalp and other parts where the hair exists, one or more of them open into the hair follicles; these ducts frequently form the habitation of a small parasite which has been minutely described by Wilson and Simon (*Phil. Trans.* 1844, and *Muller's Archives*, 1842). This sebaceous secretion serves to keep the surface moist, soft, and pliant, and in particular situations answers special purposes, as in the meatus auditorius, eyelids, nipples, &c., it also co-operates with the sudoriferous glands in separating hydrocarbonaceous matters from the blood.

The hairs and nails are appendages of the skin, but are rather modifications of the cuticle than allied to the cutis; the nails in particular are so directly continuous with the former, that after maceration they separate along with it from the true skin.

The *nails* cover the dorsal surface of the last phalanges of the fingers and toes, and have a tendency to extend around the extremity of each; they are strong, elastic, insensible plaits, curved or concave so as to fit closely to the cutis; the *root* and *borders* are concealed and fixed in a narrow, deep fold in the cutis, named *nail follicle;* the exposed portion or *body* is convex, and ends in the *free margin,* which is variously modified in different animals. The surface of the cutis to which the body of the nail adheres is termed the *matrix,* and is so vascular that the red color is seen through the nail; at the root and a short distance beyond it, it is less vascular and more dense, and causes the semilunar white spot called the *lunula.* In the follicle, at the root and borders, are a number of papillæ which secrete the nail, and on which the latter is accurately moulded, and thereby fixed in its situation; the whole surface of the matrix is also raised into fine, long, papillary plaits or laminæ, which are received into grooves in the nail, whereby the latter is still more firmly attached; from these the nail receives additional matter, and is rendered thick and strong, while the roots and margins are thin, soft, and uneven. In tearing off the nail these subjacent papillary plaits can be seen, as also the ribbed appearance on the concave surface of the former, each ridge fitting into the sulcus between two laminæ of papillæ. The cuticle is continuous with the nail a little beyond its root and lateral borders, and is also continued from the back of the pulpy end of the finger to its concave surface near the end or free edge; and as the nail is thus continuous with the cuticle, so is the matrix with the adjoining cutis. The nail is produced in a manner analogous to the cuticle; the papillæ secrete the blastema and cell-germs, these become flattened and compressed, dry, and harden into nail; as this elongates it thickens from fresh matter being added to its concave surface; thus it grows in length from addition to its root, in breadth from addition to its borders, and in thickness from addition to its concave surface. The nails not only protect the sensitive ends of the fingers, but aid them as instruments of prehension, as well as in various manual operations; they also afford a firm point of support behind the tactile papillæ, which is of essential service in the exercise of touch.

Hairs.—These cutaneous appendages, like the epidermis and the nails, are

insensible and non-vascular; they exist on all parts of the body except the palms of the hands and the soles of the feet; they vary much in strength, form, color, and extent, in different situations. On the greater portion of the body they are fine, short, soft, and downy; they grow to the greatest length on the head, but are strongest in the beard and eyelashes; they also differ according to age, sex, and race. The structure of a hair is best seen in a whisker of one of the feline tribe. The loose or projecting part of a hair is called the *shaft;* the *root* is fixed in a follicle composed of an involution of the cuticle, and of the superficial lamina of the cutis; this follicle is depressed through the cutis, enlarges into a pyramidal or bulbous form, and is imbedded in the areolar and adipose tissue, from which it receives its vessels, and by which it is so firmly implanted, that it cannot be disturbed by the forcible evulsion of the hair. The whole follicle is lined by the involuted skin; at the bottom of it the cutis presents a vascular papilla or pulp, the size and organization of which are proportioned to the size and strength of the hair; these papillæ are highly sensitive beneath the vibrissæ or whiskers of the feline animals, also beneath the eyelashes and the hairs at the entrance of the nares in man. From this papilla the hair is produced; its vessels give out the lymph or blastema containing the cell-germs; these become cells with nuclei, and are gradually condensed and elongated into a scaly, fibrous substance, which is pushed forwards by successive additions from beneath, and escapes through the opening in the epidermis, generally in an oblique or slanting manner, which gives the hair its peculiar direction in the rest of its course, and finally it ends either pointed or split. Those cells which form the outer surface or *cortex* of the hair are flat and hard, and inclose a more loose fibrous texture, named the *medulla* or pith; these external scales are imbricated, those last formed overlapping the preceding; hence the wavy, transverse lines observed on some hairs, as also the peculiar roughness experienced when drawing a hair between the fingers from the point towards the root. The central cells are less condensed, hence the structure is more loose and open, and a magnified view of a transverse section presents a cellulo-tubular appearance, like that of a piece of cane; hence a hair may often be split into fibrillæ, a change it often undergoes spontaneously at its end. Thus, as the hair follicle is lined by an involution of cuticle, so the hair itself is an evolution of the same substance, only differently modified by the papilla at the bottom of the follicle. Pigment granules are also intermingled with and adherent to the cells at the root of each hair; on these the color of the hair depends. Into the hair follicle one or more sebaceous ducts open, the secretion from which lubricates the hair through the rest of its course. The coloring matter may be unequally developed at different times, and thus a hair may present spots or shades of different color, or the secretion may altogether cease, and then the hair is gray or whitish.

As more or less cellular tissue and adipose membrane exist beneath the skin, connected to and continuous with it, and contributing to this general investment of the body, some have considered and described these as constituent parts of the integument. Although this view is not critically correct, inasmuch as they are diffused through almost every other portion of the system, yet a few remarks on these tissues may be not inappropriate in this place.

Cellular tissue is the most general and universal constituent of animal bodies; it exists all over the surface (*subcutaneous*); it connects all parts together, and fills up their interstices (*intermedius*); it incloses almost every organ, permeates its structure, and connects its component particles (*stipatus* or *parenchymal*); in some situations it is very strong and fibrous (*fibro-cellular*); in others, it is fine, soft, loose, and delicate (*reticular*); and in others it is intermingled with adipose tissue (*cellulo-adipose*). The term *cellular*

membrane has been objected to by many writers, and properly so, as it implies that it consists of distinct membraneous cells or chambers, whereas it is only a cellular web composed of fibres or threads interweaving and crossing each other, like the fibres of cotton or wool, in every direction, so as to bound very irregular spaces or areolæ of the most varied form and size, and all communicating freely. Hence the term *areolar tissue* has been adopted by some; others have named it *filamentous tissue* from its structure; and Henle has suggested the expressive title of *conjunctival tissue* from its functional office, as being the bond of union, the connecting medium between all parts of the body. As the cellular and adipose tissues are very generally associated, and in close connection, they were formerly regarded as the same structure, some cells containing fat, others containing fluid or vapor; they are, however, totally distinct elements, and, in some situations, are located separately. The difference between these tissues have been clearly set forth by Dr. William Hunter (*Med. Observ. and Inq.* vol. ii.); the cellular or filamentous tissue being composed of fine threads or bands of white, fibrous tissue, crossing each other, and leaving interstices which communicate freely; whereas the adipose consists of numerous shut sacs, having no opening or communication, each sac being a delicate, simple membrane supplied with bloodvessels, and secreting into its cavity the inorganic substance named fat.

The *areolar*, or *filamentous*, or *cellular tissue*, when minutely examined, is found to consist of filaments of variable size, some as fine as hairs, others are aggregated into firmer and broader bands and fine laminæ; they pursue, some an undulating or wavy course, others branch out into fibres, and all cross each other in the most irregular manner, so as to form a true cellular web, soft, yielding, and elastic; the latter property developed in some parts more than in others, partly depending on the bloodvessels and partly on the yellow fibrous or elastic tissue, which is disseminated very generally through the filamentous, and very abundantly in some situations where that property is required. It is very loose where free motion exists, as in the eyelids; but, where compression or support is necessary, it is compact and dense, and assumes a membraneous form, as in the superficial fasciæ and the capsules of different organs. The areolæ contain serum, or rather serous vapor, which preserves the tissue in a soft and pliant state, and the whole is traversed by numerous vessels and nerves in their course to the skin and other adjacent parts; the tissue itself, however, possesses a low grade of organization, and the fibres are neither vascular nor sensible. The bulk or quantity of the cellular texture varies not only in different individuals, but in the same individual at different periods of life, and according to the state of health: these changes depend very much on the state of the vessels passing through it, and on the amount of serous exhalation it contains. This tissue is continuous through the whole body; from the head and face it leads into the neck; from the latter, through the axillæ, into the upper extremities; also into the thoracic mediastina. and thence along the lumbar vertebræ and abdominal parietes to the pelvis and lower extremities. The areolæ also freely communicate, as is seen in anasarca, also in emphysema, in consequence of a scratch of the pleura pulmonalis from a fractured rib. This free communication can also be demonstrated in the dead body, by injecting air into it; and a portion thus treated and dried will exhibit the filamentous web and the irregular interstices, like a fine, spongy, or cottonny texture. This tissue is found in almost every part of the body, but in different proportions: beneath the skin, throughout its entire extent; and whenever free motion is required, it is loose and abundant; between all the muscles, confining them in their situation, but still admitting of their actions and change of form and place; around each it is condensed into a sheath, and is prolonged into it along with its nutrient vessels and nerves, and forms smaller sheaths for each fasciculus and fibre,

but it does not penetrate the sarcous element of the latter; around the nerve it is disposed in an analogous manner, forms a sheath for each cord, and for each fibre, but does not extend into the latter; it also incloses the bloodvessels in sheaths which confine them in their proper position, and defend them from the pressure of the adjacent parts; it also invests the serous and the mucous membranes, and the different glands, and accompanies the vessels of the latter through their intimate structure; in some glands, as the mammary and salivary, it is more abundant than in others, as the liver, kidneys, and testes. In some few situations it is in very small quantity, as in the heart, and in the brain and spinal cord; in the latter but little more can be found than the fine sheaths for the capillary vessels; and its very existence may be doubted in cartilages, in the vitreous table and compact laminæ of the bones, and in the dental ivory and enamel.

Adipose tissue consists of two distinct elements: one is the secreting membrane, the other is the secreted product. The former consists of fine, transparent, membraneous cells or sacs surrounded by capillaries; each sac is somewhat round, but, from several being aggregated together, they become compressed, and partially flattened, so as to assume various figures. The vessels pass in the interstices between the cells, and surround each by a delicate inosculation. In some situations the cells are very large, and then the tissue is loose and soft, as in the orbits or cheeks, around the kidneys, &c.; in other places they are small and firm, and present a granulated appearance, as in the scalp, and on the palmar and plantar surfaces of the hands and feet; each cell is filled with adeps, a soft, yellowish, oily, or unctuous unorganized substance, presenting great variety as to quantity, color, and consistence in different individuals, at different ages, and in the different classes of the animal kingdom. In the fœtus it is white, and forms a thick and firm covering all over the surface, beneath the skin; and but little is found deeper seated, or in the cavities. In youth it is but moderately diffused in all situations; in middle age it is generally increased in quantity in all parts of the body; in old age it nearly disappears from the surface, but is often accumulated in the cavities, as about the heart and large vessels, around the kidneys, in the omenta and mesentery, and about the rectum and colon. Although the adipose and cellular tissues are generally associated together, yet they are distinct in some parts; in the medullary canals of the long bones there is but little of the cellular, the space being occupied by a peculiar kind of adipose tissue, the cells very fine and reddish, and the adipose matter very soft, and sometimes semifluid; in the omenta, and along the mesenteric vessels, and upon the heart, the adipose tissue is often abundant. though very little cellular tissue exists in those situations. The fat contributes to the covering of the body, and, being a bad conductor of heat, may assist in retaining its temperature; by filling up numerous interstices it adds to the general symmetry; it affords a soft and yielding support to different organs, and defends vessels, nerves, and other parts from pressure; it may also serve as a reservoir of nutritive materials, from which the system may derive an occasional supply.

SECTION II.

ANATOMY OF THE NOSE, OR ORGAN OF SMELL.

THE *nose* is situated between the orbits, above the mouth and glottis, and in front of the pharynx and of each tympanum, and communicates with all these regions; though it occupies a median place, it is a double organ, being

perfectly divided by a septum into two symmetrical portions, called the *nares* or *nasal fossæ.* These passages have two distinct offices to perform: first, they constitute the organ of smell, the olfactory nerve being distributed to the vascular membrane covering their irregular and convoluted surface, the anterior opening of each having an horizontal aspect, in conformity to man's erect posture, and adapted to direct the odoriferous air upwards towards the sentient surface: and, second, they serve as avenues to the respiratory organs, and are, therefore, constructed of such unyielding materials as may secure a free and permanent passage for the atmosphere: their surface also is rendered highly sensible by the filaments of the fifth pair of nerves, and this sensibility enables it to take cognizance of the quality of the air, and gives warning to the nervous centre of what may be injurious to the system, and by reflex power excites the action of the expiratory muscles to effect a violent expulsion of the noxious or offending matter. This action is often spasmodic and repeated, as in sneezing. From the proximity of the nose to the mouth, the sense of smelling becomes subservient and auxiliary to that of taste in the selection or rejection of food. For the study of the anatomy of this organ, the student should be provided with a vertical section of the dry skull, and of one in the recent state, the section made close to one side of the septum narium. This organ may be divided into two parts: the one is anterior or external (commonly called the nose), and is composed of cartilages and soft parts; the other is posterior or internal (the nares or nasal fossæ), and is composed of several bones covered by a very vascular mucous membrane. First examine the external apparatus, or the nose.

The *nose* is essentially formed of cartilages; one occupies the median line or septum, the others are placed on each side, and form the alæ; they are continuous laterally with the superior maxillary, and superiorly with the margin of the nasal bones, which form the prominence called the *bridge of the nose,* which is so very variable in different individuals; inferiorly they bound two oval openings (the *nostrils*); these are directed downwards, separated from the mouth by the upper lip, and from each other by the septum, beyond which the integument forms the projection called the *tip of the nose.* Each nostril has its long axis from before backwards, and is partly surrounded by stiff hairs (*vibrissæ*), which bend across it, and prevent the entrance of foreign particles, and, like the whiskers of feline animals, convey the slightest impression to the sensitive nerves in their bulbs, whereby the expiratory muscles are excited to immediate action. The skin covering the extremity or tip and alæ of the nose is thick, is inflected into each nostril, and becomes mucous membrane at the roots of the vibrissæ; it is furnished with numerous sebaceous follicles, the small ducts of which open on the surface, and frequently appear as black dots, owing to the adhesion of external matter. The sebaceous secretion can often be forced out in fine, long threads, like small worms. These follicles are occasionally hypertrophied, so as to cause a considerable enlargement, and an irregular, tuberculated state of the extremity of the organ. Beneath the integuments are the several subcutaneous muscles, pyramidalis nasi, compressor, &c.; these have been already examined (page 9). These muscles can alter the form of the nostrils, but cannot wholly close them.

The cartilages, or fibro-cartilages, are five in number, one in the centre, one at each side, and one inferiorly in each ala. The *septal* or *median cartilage* is of considerable strength, and is true cartilage, flexible and elastic; it not only separates the nostrils, but also the anterior portions of the nasal fossæ; it is somewhat triangular; the anterior margin is connected above to the inside of the suture between the nasal bones, and below to the two lateral cartilages, beneath the integuments. The posterior border leads downwards and backwards, and is attached to and often continuous with the nasal or per-

pendicular plate of the ethmoid; its inferior border, which leads from behind downwards and forwards, is received between the laminæ of the vomer and the rising spines of the palatine plates of the superior maxillary bones. This and the lower portion of the anterior edge are rounded off anteriorly, and present a thick, convex border, which is received between the two alar cartilages, and forms the septum between the openings of the nostrils. The apex enters the angle between the vomer and ethmoid lamella, and is prolonged backwards in the former bone for some distance, sometimes even to the azygos process of the sphenoid. The nerves of Cotunnius are parallel to it, and often inclosed in the same bony canal. This cartilage is very thick anteriorly, and presents several small mucous pores; it is inclosed in thick mucous membrane, is not always vertical, but frequently projects to one side, and is concave to the opposite. A similar deviation is often remarked in the bony septum, where the vomer meets the ethmoid plate, and a considerable osseous projection to one side is not uncommon.

The *lateral nasal cartilages* are two on each side, superior and inferior; the latter are also called alar cartilages. The *superior lateral* is attached externally and posteriorly to the nasal process of the superior maxillary bone and to the inferior margin of the nasal bone; anteriorly and internally it is connected to the opposite one and to the septal cartilage, of which latter they are by some described as a part, or as a lateral process; however, they are always distinct from it, and move upon it. The inferior border is connected by fibrous tissue to the following. The *inferior lateral* or *alar cartilages* form the upper part of each ala, the tip or lobe, and the boundary of the nasal openings; each is of a very irregular form; it is curved around the orifice of the nostril in a peculiar manner, is somewhat semicircular, the cornua converging behind towards the bone, and not meeting; the largest part is in front, and is deeply excavated, thereby enlarging the cavity of the nose, and extending it into the tip or lobe; the external crus is thin and long, curved in the form of the ala, the upper part of which only it forms, the lower portion being composed of the thick folded integument; the inner limb is thicker and larger than the external, and on a plane inferior to it, is in contact with that of the opposite side, beneath the septum, which is received between them, and beneath which each alar cartilage can glide to either side. The internal crura of the opposite cartilages pass horizontally backwards, and are connected by fibro-cellular tissue to the nasal spine of the superior maxillary bones, and form the projecting ridge between the two nostrils; this ridge is named by some the *columna;* it is nearly horizontal, but variable. The upper margin of the alar cartilage is connected by fibrous tissue to the border of the superior lateral cartilage: all these lateral cartilages are very movable, as they are attached by fibrous tissue to the bone and to each other; they are easily acted on by the superimposed muscles, which can move the whole organ, or alter the form of the openings, enlarge and contract, but cannot perfectly close them.

Fig. 71.*

The Nasal Fossæ are bounded by several bones, which are all covered by a very delicate periosteum, inseparably united to the highly sensible lining mucous membrane; to the anterior part of the bones of the nose, the cartilages of the septum and

* The external wall of the right nasal fossa. 1. A section of the basilar process of the

alæ nasi, which have been described, are attached. Each naris is bounded superiorly by the lateral nasal cartilage, and by the nasal frontal, ethmoid, and sphenoid bones; the roof is arched, and has different aspects; the anterior part looks downwards and backwards, the middle perpendicularly downwards, and the posterior part downwards and forwards: the floor is nearly horizontal, but with a slight inclination backwards, and concave in the transverse direction, and is formed by the palatine plates of the maxillary and palate bones, and in part by the velum palati: the external wall is formed by the superior maxillary, unguis, spongy, ethmoid, and palate bones, and by the internal pterygoid plate. The septum is composed of the azygos plate of the sphenoid, the nasal lamella of the ethmoid, the vomer, the spines of the palate and maxillary bones, and the septal cartilage. The external wall of each naris is deeply grooved by three fossæ, or meatuses, the superior, middle, and inferior; these are situated between the spongy bones; the middle is the widest. The nasal or lachrymal duct opens into the anterior third of the *inferior meatus*, the Eustachian tube behind, but on a level with the inferior spongy bone. At the side of the septum anteriorly may be observed, in the dry skull, the superior orifice of the anterior palatine canal, which, although a distinct opening superiorly in each naris, yet inferiorly, or towards the mouth, it forms with the one of the opposite side a common foramen. This communication between the nose and mouth does not exist in the recent state in the human subject, being closed by the nasal and palatine mucous membrane; but in some animals it is permanently free, and contains some ganglionic nervous filaments. Into the *middle meatus* the antrum maxillare opens by a small oblique slit, which looks backwards and inwards, and although in the dry bone it appears tolerably large, yet in the recent state it admits only a small probe, on account of the mucous membrane being thrown into a fold around it. In front of this is a groove, named the infundibulum, which leads from the frontal sinus; into this groove the anterior ethmoid cells open. If the anterior part of the middle spongy bone be cut off, this projecting, curved tube will be seen; it often leads to the opening of the antrum. Into the *upper meatus* the posterior ethmoid cells and the sphenoid sinuses open. Above the upper or third meatus there is frequently an oblong, deep sulcus, in a more vertical direction than the other meatuses; the sphenoidal spongy bone bounds this above; when present, the sphenoid sinus opens into it; it is named the *fourth meatus*, or *summus*. This spongy process is sometimes coiled inwards, so as to present even a fifth fossa or meatus. The external wall of each naris is rendered, by means of these several fossæ, very extensive, and thereby not only is the sentient surface of the membrane greatly enlarged, but the many irregularities and offsets must serve to detain for a longer time the odorous air, which latter can only be displaced gradually, and thus the impressions upon the olfactory nerves must be prolonged. Each naris opens posteriorly into the pharaynx, above the velum, by an oblong oval opening; these are separated from each other by the vomer, the internal pterygoid plates bound them externally, the sphenoid above, and the palate bones and velum below.

All the internal surface of the nose, and of the sinuses communicating with

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occipital bone. 2. A section of the body of the sphenoid bone. 3. The sphenoidal sinus. 4. A section of the crista galli of the ethmoid bone. 5. The frontal sinus. 6. Os nasi of right side. 7. The superior spongy or turbinated bone. 8. The middle spongy bone. 9. The inferior spongy bone. 10. The superior meatus of the nose; the figures are placed immediately in front of the orifice of the sphenoidal sinus. 11. The middle meatus. 12. The opening of the antrum Highmorianum, or sinus maxillaris. 13. The inferior meatus. 14. The anterior nasal spine. 15. The internal pterygoid process. 16. The external pterygoid process. 17. The palate process of the superior maxillary bone, separating the mouth from the nasal fossæ.

it, are lined by a soft, vascular, and highly sensible mucous membrane: this is the *pituitary* or *Schneiderian membrane*. It is continuous anteriorly with the integuments, adheres to all the internal surface of the bones of the nose, lines the sinuses, is continuous through the nasal duct with the membrana conjunctiva of each orbit; round the lower extremity of each duct it forms a slight circular fold, valvular in front; this elongates the canal, and contracts the opening to a small size: posteriorly it is continuous with the membrane of the pharynx and Eustachian tubes. In some places it adheres inseparably to the periosteum, so as to deserve the name of a fibro-mucous membrane: in others it is villous, very vascular, soft, and thick, as on the septum and turbinated bones; and in these situations both it and the submucous tissue are loose, cellular, or spongy, and probably possess some of the properties of erectile tissue. At the extremities of the latter, particularly of the inferior, it forms thick, fleshy-looking folds or lips; it closes the ethmoidal, spheno-palatine, and incisor or anterior palatine foramina, and smooths off many of the irregularities so remarkable in the dry sections. In the sinuses it is pale and thin; it is constantly moistened with a mucous secretion, but mucous glands are not distinct in it; like other mucous membranes, it possesses an epithelium which is columnar, except in the sinuses, where it assumes the character of the squamous; it is furnished everywhere with cilia, even in the sinuses, in which, in the lower animals, the vibratile motions have been observed to produce currents towards their openings.—(Cruveilhier's Anat. p. 857). The olfactory, or first pair of nerves, are distributed to it on the septum and ethmoidal region in the form of numerous plexuses; it is also supplied on each side and on the septum with branches from the ophthalmic and superior maxillary divisions of the fifth pair. The *olfactory* may be seen by gently tearing off the membrane from the bones, commencing at the upper part of the septum, or of the spongy laminæ; or when the bone has been exposed on one side, break it, and with the forceps pick off the fragments from the opposite membrane. The nerves may be then seen descending through the cribriform plate, inclosed at first in short bony tubes, and then in fibrous sheaths; they soon expand in plexuses of fine filaments. On the septum these can be traced for nearly an inch very distinctly; the fibrillæ then enter the mucous tissue, the exact mode of termination in which cannot be ascertained: externally many of the olfactory nerves can be traced to the superior spongy bone, but very few to the middle, and none to the lower. The branches of the fifth pair do not pursue the same plexiform arrangement; some of these enter the mucous tissue abruptly, others extend some distance as distinct, undivided filaments before they terminate. The septal branches of the spheno-palatine, or nerves of Cotunnius, descend in this form obliquely forwards, all along the septum, as far as the foramen incisivum. The first pair endow the superior portion of this membrane with its peculiar sense or power of smelling; while its general acute sensibility depends on the fifth pair, the general feeling nerve of the head. Majendie's experiments prove that the branches of the fifth pair in the nose are very sensible to acid or pungent odors, in the same manner as the surface of the eye, and hence he inferred that these nerves are accessory to the special function of this organ. However, it may now be considered as an established fact that the first pair of nerves are alone olfactory; they are wholly distributed to the mucous membrane, and give off no motor filaments; irritation of their bulb or branches, in experiments on the living animal, excites no muscular effort, direct or reflex. Valentin's experiments also demonstrate that destruction of these nerves annihilates the sense of smell without impairing sensibility, and that the membrane will continue sensible to irritating vapors, which will excite sneezing and other muscular exertions through the fifth pair. No doubt the acuteness of smell must be diminished by division of the fifth, because the

functions of the membrane, and of its sense, become impaired if secretion be suspended; and this is the effect of division of this nerve. The membrane, when dry, is not susceptible of the impressions made by minute odoriferous particles: we may, therefore, affirm that the olfactory are the true nerves of the special sense of smell, and that the fifth pair are accessory in so far only as they tend to maintain the due organization of the membrane and the secretion from its surface.

SECTION III.

ANATOMY OF THE TONGUE, OR ORGAN OF TASTE.

The apparatus for the exercise of this sense, though less complex than that for smell, is in most essential respects analogous to it, as also to that for touch, of which latter many regard it as a modification or refinement. In each case contact between the external substance and the sentient surface is requisite, and motion, friction, or compression, render the sensations more perfect; for the perception of taste, however, the object applied must be either in a gaseous or fluid state, or soluble in the moisture of the sentient surface; if perfectly dry, the sensation of contact only is conveyed to the sensorium.

Taste may be defined to be the faculty of distinguishing, not only the temperature and many of the physical characters of bodies (in which respect it is similar to touch), but also the peculiar properties, chemical and others, which certain substances alone possess, and which are, therefore, called "sapid bodies." This sense is greatly assisted by that of smell; the odorous effluvia from the sapid body being first noticed by the olfactory nerves, and then more fully recognized or discriminated by the gustatory organ. The faculty is most delicate and exalted on the anterior, the lateral, and the posterior parts of the upper surface of the tongue; the central portion possesses it in a less degree; it also resides, but feebly, in the palate, and membrane of the mouth generally, to which surfaces the fifth pair of nerves are distributed.

Placed at the entrance of the alimentary apparatus, the great object of the tongue, and of its special endowment, is the choice of food, to reject what is nauseous and noxious, and select and retain what is grateful and nutritious; and it may be affirmed as a general law (though with some few striking exceptions), "that what is good to the taste will prove nutritive to the system." The tongue also, in most animals, is an active agent in suction, prehension of food, mastication, insalivation, and deglutition; and in man it is the great instrument for speech. In the animal series it presents great variety in form and structure, which are always in accordance with the functions it is to execute, and with its endowments and privations.

To fulfil its several functions, the tongue must possess a very complex structure; it is, accordingly, highly organized; six cerebral nerves are distributed to it; it is freely supplied with bloodvessels, is covered by a sentient and very sensitive papillary surface, and is essentially composed of muscular and very irritable fibres, which form an intricate interlacement, not unlike the wall of the left ventricle of the heart. This muscular structure can change the form and consistence of the organ with wonderful rapidity; can move it in every direction, so as to bring and retain its sentient papillæ, in contact with foreign matter; can strike its point with agility against the lips and teeth, to produce the articulate sounds of speech; can press and bruise the food against the palate, gums and teeth; can, with great dexterity, collect the particles together, pick them out of every recess, and compress them into one mass, and then force the whole backwards through the fauces.

The tongue is described as of various forms, triangular, oval, irregularly square; from the nature of its structure, however, it cannot present any uniform shape. When detached and extended it is somewhat oval, the large end (base or root) being posterior and inferior; the small end (apex or tip) being superior and anterior; the middle portion (body), placed within the lower alveolar arch, is broadest opposite the last molar teeth, and, being thicker posteriorly than the vertical depth of the arch, it rises above the level of the molar teeth, so that when the mouth is closed, its upper surface, which is a little grooved, is in contact with the palate. A median groove above, a cellulo-adipose line below, and a vertical fibro-cellular septum extending through it, render the apparatus of taste double or symmetrical, like that of the other senses. We shall next proceed to the more accurate examination of this organ, and consider it as presenting a base, an apex, a superior and inferior surface, and two lateral borders or edges.

The *base* of the tongue is posterior and inferior, and very thick; is connected to the body of the os hyoides by muscles, and by a fibrous tissue named the *hyo-glossal ligament*, above which it is connected to the epiglottis by three smilunar folds of mucous membrane (glosso-epiglottidean), the central of which is very prominent, and is named frænum-epiglottidis, or posterior frænum of the tongue; the os hyoides forms, as it were, a foundation for the tongue; and, as the larynx is attached to it, the latter follows many of the motions of the tongue. The *superior surface* is rough, from the numerous papillæ scattered over it, and which will be more particularly noticed presently; a median groove also extends along it, which is deeper behind than before. At the posterior extremity of this groove we generally observe a small circular depression, opposite the uvula, named foramen cæcum. The *apex of the tongue*, or the anterior third, is thin and pointed or rounded; all this portion is enveloped by mucous membrane, and unattached, and can move with freedom in every direction. The *sides* or borders of the tongue are smooth and convex, thicker behind than before, and are connected by the stylo-glossi muscles to the styloid processes of the temporal bones. The *inferior surface* is irregular, and presents posteriorly in the median line a dense fibrous tissue, which ascends vertically to the mucous surface; this forms a partial *septum*, and is attached inferiorly to the hyo-glossal ligament. In many animals it is a long, bony style, with a fibrous septum extending from it; in some it is cartilaginous, and it has been described by some writers as presenting this tissue in man; it is seldom, however, more than fibro-cellular tissue; it becomes weak and indistinct anteriorly; to a certain extent it renders the tongue a symmetrical organ, similar parts being found on each side of this median septum. In that paralytic affection, termed hemiplegia, this formation becomes evident, as one-half only of the organ is then affected with paralysis. This septum, however, is not perfect, as some of the intrinsic muscles of the tongue pass through it from one side to the other. The anterior portion of the inferior surface is smooth and free, and presents the fold of membrane called anterior frænum linguæ, extending from it to the inside of the symphisis of the jaw, beneath the incisor teeth. On each side of this is a bluish appearance, caused by the ranine veins shining through the membrane, and at its base is the prominent crest, with the two openings of the Whartonian ducts.

The muscular structure of the tongue consists of intrinsic or true lingual muscles, and of extrinsic, or those which have additional attachments. The extrinsic or accessory muscles are the stylo-glossi, hyo-glossi, genio-hyo-glossi, and palato-glossi; as these muscles have been already described (p. 55), we shall only now allude to them in connection with this organ.

The *stylo-glossus* of each side runs in a superficial fasciculus along the border of the tongue as far as the apex; a deeper band intermingles with the

hyo-glossus, and some fibres pass in transversely, and join the intrinsic muscles; these muscles can raise and retract and expand the tongue transversely, or, acting singly, can move it to either side.

The *hyo-glossi* muscles ascend from the os hyoides nearly parallel; approaching the tongue they expand, and are inserted between the stylo-glossus and lingualis of each side; their combined action will depress the margins of the tongue, contract it transversely, and render it convex from side to side.

The *genio-hyo-glossi* are the largest of this class; the convex border of each fan-shaped muscle ascends vertically on each side of the median septum, and is inserted into the dense mucous chorion of the upper surface, from the base to the apex; the two muscles are parallel, and separated below by cellular and adipose tissue, and above by the median septum, into which also some fibres are inserted; their anterior border is beneath the frænum linguæ: their action must vary according as the whole, or part only, of both, or of one muscle, is engaged; both will raise and draw forward the os hyoides and tongue, and protrude the latter from the mouth; their anterior portions, on the other hand, will retract it, and bend the tip behind the lower incisor teeth, so as to make the dorsum of the tongue convex from before backwards; the central portions will depress the middle of the tongue, and form a groove leading downwards and backwards: if one muscle only act, it will protrude the tongue to the opposite side, as is well seen in cases of hemiplegia.

The *palato-glossi*, or anterior palatine arches, are inserted into the posterior part of the side and upper surface of the tongue, and partly join the stylo-glossi; their action will be to raise the margins of the base of the tongue, and approximate the latter to the velum.

The intrinsic muscles of the tongue consist of fleshy fibres running in different directions, and interlacing very like those of the heart, excepting that there is more adipose tissue intermingled with them. This tissue is peculiar; it is very soft, almost fluid, and has but little or no cellular membrane along with it. If the tongue be boiled for a short time, the true lingual fibres can be more distinctly traced, and their attachments to the mucous chorion seen; the latter is thereby made more firm and resistant. In some animals, when treated thus, it assumes an almost cartilaginous appearance. Gerdy has described the lingual muscles accurately, and names them the superficial, the two deep, and the vertical of each side, and the transverse. The *superficial lingual* covers the edge and upper surface on each side of the middle line, and its fibres are intimately attached to the dense investing membrane. The *deep lingual* are two fasciculi on each side, between the hyo and genio-hyo-glossi muscles, attached posteriorly to the dense submucous tissue. The *transverse lingual* are beneath the superficial, perforate their fibres at right angles, and are attached to the membrane towards either side. The *vertical lingual* descend from the superior membrane to the inferior surface, perforate the other fasciculi, and bend obliquely towards the base of the tongue. While the whole organ is moved in various directions by the extrinsic muscles, these intrinsic fibres can effect changes in form and density with infinite variety; these changes must affect the sensitive papillæ, bring the food into contact with them, and move it from one to another; they are also instrumental in mastication and in deglutition.

As a sentient organ, the mucous or papillary membrane is most important; this is continuous with the general mucous membrane of the mouth and digestive apparatus; on the antero-inferior lateral portions of the tongue it is loose and simple in its organization; on the lateral borders small pores are distinct, orifices of submucous glands; over the base and posterior part, in front of the epiglottis, it is smooth and rather loosely connected; mucous glands are obvious beneath it, and their small ducts open upon the surface:

over the whole dorsum of the tongue is rough, from the presence of numerous papillæ of various forms and texture. Malpighi has given an accurate account of the membrane covering the tongue, and but little has been added to our knowledge since; he has established its similarity to the cutis, and that it is composed of, first, a dense chorion; second, numerous papillæ furnished with nerves and vessels; third, a rete mucosum, or pigment layer; and fourth, an epithelium, or epidermis. In the human subject, however, the reticular layer cannot be distinguished, but in those animals whose tongue is wholly or partially black, a pigment lamina exists. The *chorion* is very dense, and under the knife feels a little crisp; a section exhibits its compact texture, and its deep surface presents a slight yellow tint, probably from some yellow tissue intermingled with it; the muscular fibres are inserted into every part of it: when viewed with a lens they appear to enter its tissue, and some even appear to extend to the bases of the conical or cuticular papillæ. The entire of the upper surface of the tongue, except in front of the epiglottis, is studded with eminences of various forms, some glandular, but most are papillary. The glands and papillæ have been occasionally confounded by writers. The *lingual*, or the *mucous glands*, are most obvious posteriorly, and where the secretion is most required at the moment of deglutition. They form small projections in this region through the membrane, which is thin and rather loosely adherent to them, except in the centre of each, where there is a small pore, which is the excretory orifice; through this the fluid can be expressed by pressure, whereas the papillæ are closely invested by membrane, and present no orifice or pores. Lingual glands also exist along the borders and on the under surface of the tongue, but are not evident on the dorsum. There are probably, however, minute follicles which furnish the secretion that constantly moistens this surface, and which, together with the epithelial scales, form the fur or coat which in fever and gastric disease often accumulates into a thick adhesive lamina. The *papillæ* have been variously designated from their form. They present such different characters that we may infer they have different offices or functions. Near the posterior part of the body of the tongue the most conspicuous papillæ are arranged in a peculiar manner: two rows, each six or eight in number, converge behind so as to inclose a V-shaped space. These remarkable papillæ have been variously designated by authors calyciform, circumvallate, truncated, pyramidal, button-shaped, &c., &c. The name *calyciform*, applied by Cuvier, is very appropriate, as each is partially inclosed in a small membranous cup, whose circular margin is loose, and, according to Cruveilhier, papillary also. To the bottom of this cup the papilla adheres by a narrow stalk; from this it swells out like a small mushroom, and ends in a firm, round, prominent base, a little flattened, to range on a level with the surrounding parts. At the angle of junction of these two rows of calyciform papillæ is the deep lacuna, named "foramen cæcum;" mucous follicles open into it, but its margins are probably papillary. Not unfrequently, instead of a lacuna, a papilla occupies its place.

Anterior to these, the dorsum of the tongue presents a variety of other papillæ, generally arranged under two classes, and named from their shape fungiform, and conical or filiform. The *fungiform* are chiefly towards the tip, and near each side; they have a red color, and can be best seen in the living organ; if any sapid substance be then applied, they become erect and distended, and appear to move somewhat, probably from the excited action of the subjacent muscular fibres; their base projects a little, and is larger than their apex, which sinks below the surface.

The *conical*, or *filiform papillæ*, are whiter and more cuticular than the others; they occupy the greater portion of the dorsum; they are bent backwards, but, by scraping the tongue, they can be raised and turned forwards; they then give the tongue a rough or brush-like appearance. These papillæ

do not appear so organized as the fungiform or calyciform, and are chiefly situated on that part where most pressure against the palate and the food must occur in mastication and deglutition. In many of the lower animals these papillæ are very long, white, dense, and prickly, and bent towards the pharynx, and must serve in the retention, compression, and direction of the food.

All the papillæ, as well as the mucous surface, are covered by a scaly epithelium, which can often be detached, particularly from the conical papillæ, in large patches, by immersing the tongue in boiling water, or by the application of a strong acid. During life this occasionally occurs accidentally, as also in certain fevers; in some animals it is very dense, and admits of easy separation; it forms an accurate covering for the surface of the organ and for all the papillæ, which are thus strengthened in their tissue and defended from the action of foreign bodies, as well as from pressure and friction.

The minute structure of the papillæ is involved in obscurity. They appear to the naked eye smooth, but, when viewed with magnifying powers, they present an irregular surface, villous or papillary; fine injection partially colors and enlarges them; the capillaries form arches and complicated loops upon each; the interior is filled with a soft tissue, covered by a delicate membrane beneath the epithelium. This interior soft tissue probably contains the nervous structure, but the exact form or mode of arrangement of the latter has not been ascertained; the nervous filaments can be traced into the immediate vicinity of each, but become too soft and minute to pursue any further. An accurate description of the lingual papillæ, microscopically examined, has been published in Bowman and Todd's Physiology of Man, page 437.

The nerves of the tongue have been already described: three on each side, the ninth or hypoglossal, the lingual branch of the fifth or the gustatory, and the glosso-pharyngeal division of the eighth. The *ninth* is almost wholly distributed to its muscles; from the os hyoides it passes upwards and forwards, between the genio-hyo-glossus on its inner side and the hyo-glossus on its outer; on the outer surface of the latter some branches communicate, and form a plexus with filaments of the gustatory nerve. This plexus, between the motor and sentient nerve, is named the *lingual*, and is distributed to the surrounding muscles and glands. The lingual nerve divides into numerous branches, which are lost in the extrinsic and intrinsic muscles of the organ. Some filaments can be traced upwards, even to the mucous chorion, into which the muscular fibres are inserted, and some accompany filaments of the gustatory as far as the tip or apex. The *gustatory* proceeds in an arch from behind forwards, supplies the sublingual glands and mucous membrane, and its terminating filaments can be followed to the mucous surface on the tip and side of the tongue. The *glosso-pharyngeal*, also, runs in an arched manner, but deeper than the last, and passes between the posterior part of the stylo and hyo-glossi muscles to the base of the tongue; its branches take rather a transverse course, and are distributed superficially on the base and posterior part of the organ, to the calyciform papillæ, and glosso-epiglottidæan folds of mucous membrane. Many facts and experiments have established the opinion that the lingual or ninth nerves are the true motor, and that the fifth and glosso-pharyngeal are both the sentient and sensitive nerves of the organ. The sense of taste especially resides in the papillæ at the point, sides, and base; those in the two former situations appear most quickly sensitive to the qualities of sapid bodies, while the posterior papillæ retain the impressions for a longer time. The conical papillæ on the dorsum do not appear to possess the sense so acutely, probably from being covered by a more dense epithelium; they are, however, highly sensitive to contact, and may thereby serve to regulate the muscular efforts in mastication. This region of the tongue is supplied superficially from the gustatory, and the subjacent muscu-

lar fibres from the lingual nerves. The organization of the papillæ, being extremely complex, may account for the difference between the sensitive and sentient properties of different regions, rather than any peculiar endowment of particular nervous filaments proceeding from a common trunk. The glosso-pharyngeal has been already considered as a compound nerve, supplying the base of the tongue with sensation and sense, and the surrounding muscles, through its primary branches in the pharyngeal plexus, with motor power; this nerve also maintains a remote but very obvious sympathy between the tongue and the stomach, and associates in harmonious action all the apparatus for deglutition.

The tongue is very vascular, particularly its surface; it receives its blood from the two lingual arteries, also from the pharyngeal and palatine: the lingual are the principal. These vessels are remarkable for anastomosing, but feebly, on opposite sides, so that if a different colored fluid be injected into each, the two sides of the organ will be colored accordingly. A slight communication, however, takes place on the dorsum of the base and at the apex between the ranine arteries. The veins escape from the tongue, partly at its base and root, and partly by two ranine branches, one at each side of the frænum, which joins the veins in the neck.

SECTION IV.

ANATOMY OF THE ORGANS OF VISION.

Although the apparatus for this sense is double and symmetrical, so that each eye can act singly, yet the muscles which move each, have such consent and harmony, that both are generally directed simultaneously to the same object, and therefore co-operate, and act as a single organ, whereby vision is rendered more powerful and accurate. The two sentient nerves, also, which are very large, are most intimately connected by their commissural and decussating fasciculi, so that, although the external apparatuses for this sense are more separate and distinctly double than those for smell and taste, yet the connection between their essential nerves is much more impressed with the character of unity than in those of any of the other senses; a fact which mainly accounts for their sympathy in health as well as in disease. By the sense of sight we acquire a knowledge of the existence, position, relation, form, and color of external bodies, by means of the rays of light which those objects are continually sending off, being either luminous themselves, or reflecting the light received from other bodies. Each optic nerve is expanded into a concave, delicate, membraneous network, named the retina, and is so organized as to receive an impression from these luminous rays, and to convey to the sensorium the sensation of light. Such an impression, however, would be far from distinct vision. To accomplish the latter, those rays of light alone which proceed from the object must impinge upon the retina, and each pencil of rays must also impinge exclusively on some one part of it. To effect these purposes, each pencil of rays from every point of the object must be collected into one point or focus upon the nervous expansion, and this can only be effected by bending the rays from their straight course, that is, by refracting and collecting them into foci upon the retina: hence the eye must act as a powerful optical instrument. It is, therefore, furnished internally with transparent fluids and humors of varying density, and with a powerful double convex lens. By the nice adjustments of these different parts there is produced, upon the concave surface of the expanded optic nerve, a minute

but accurate image of the objects before it, in which are represented the outlines, forms, colors, lights and shades of each in their exact relative position. As the central parts of the retinæ are the most sensible, the images of objects must fall upon them, and therefore the eye requires a capability of motion, so as to change its axis towards those objects wherever situate; hence it is furnished with several muscles which, aided by the motions of the head and atlas on the axis, and of the spine generally, can move it with rapidity and exactness; hence, too, it requires a soft and yielding support, and accordingly it rests on a mass of soft adipose tissue, on which it can roll freely in every direction. In addition to its sentient nerve, an organ of such complex and delicate structure must possess the usual elements of organization; it is, therefore, duly supplied with vessels and nerves; special protection is afforded to it by its being lodged in a strong, bony cavity, open only in front, and in which aspect it is defended by the eyelids, with their cartilages and ciliæ, and powerful sphincter muscles; and, lastly, to keep the surface of the transparent cornea (the window of the eye) clean, clear, and polished, as well as to facilitate the motions of the globe and of the palpebræ, a mucous membrane lines the latter and coats the former, and whose surface is still further moistened by the tears, for the supply and removal of which a distinct apparatus, lachrymal, is superadded. Thus protected and defended, the eyes are at the same time placed in the most favorable position for commanding an extended range of vision, being situated at the forepart of each orbit and at the upper and anterior part of the face. In considering the anatomy of the eye, we must examine not only the globe, or the visual instrument itself, but also these several appendages, or "tutamina oculi," which, though not directly ministering to the sense, are yet so connected with its general well-being, that a derangement of any one of them will more or less impair the functions of the whole organ. The appendages of the eye are the orbits, supercilia, palpebræ, cilia, conjunctiva or mucous membrane, lachrymal apparatus, orbital muscles, nerves and vessels. In studying the anatomy of the eye and its appendages, the student should be prepared with a section of the dry skull, to examine the orbit and its communication with the nose; he should next, on one side of the subject, carefully dissect the orbicularis, or sphincter palpebrarum muscle; examine the structure of the palpebræ, the puncta lachrymalia, and pass fine wires or flexible pins through each of the latter into the nasal sac, duct, and nose. On the other side, the roof of the orbit must be raised in the manner directed (page 434), the orbital muscles cleaned, and the several vessels and nerves dissected. Lastly, he should procure some fresh eyes of the ox, sheep, and pig, raise the several tunics, and examine the structure of each. It is difficult in a dissecting-room to procure the human eye sufficiently fresh for a satisfactory dissection; but the student should endeavor to do so, as he cannot fully comprehend its structure in man merely by examining it in the quadruped.

Orbits are conical, osseous recesses, their sides of unequal length, and joined to each other at angles, so as to form quadrangular pyramids; seven bones contribute to their formation, viz., the frontal, sphenoid, ethmoid, malar, maxillary, unguis, and palate (*see* Osseous System). In each orbit we have to consider the base, apex, roof, floor, inner and outer wall, angles, axis, and foramina. The *base* or circumference is very wide and open, directed forwards, outwards, and a little downwards; is somewhat quadrilateral, but wider externally than internally; and the transverse diameter being larger than the vertical, the former is directed obliquely outwards and backwards, as the outer margin of the base is cut off obliquely, whereby lateral or external vision is extended. The vertical diameter of the base is perpendicular in the young, but, as the frontal sinus and superciliary arch become developed, the upper margin overhangs the lower, and then this diameter leads obliquely down-

wards and backwards, and consequently the eyeball is directed downwards more freely than upwards. This margin of the orbit is thick and strong, formed superiorly by the superciliary arch of the frontal bone, in the inner third of which is the notch or foramen for the frontal nerve and vessels; externally by the malar, which joins the external angular process of the frontal; inferiorly by the malar and by a short portion of the maxillary, the latter being overlapped by the former, beneath the inner end of which is seen the infraorbital foramen, vertically beneath the supraorbital notch; internally by the ridge of the unguis, in front of which is the nasal or lachrymal fossa and the nasal process of the maxillary bone. The *apex* is in the posterior narrow part of the cavity, and is open; it corresponds to the inner or large extremity of the superior foramen lacerum or sphenoidal fissure, and is below and a little external to the optic foramen. The *superior wall*, or the *roof*, is smooth, thin, and concave, supports the anterior lobe of the cerebrum, is formed chiefly by the frontal bone, but posteriorly the lesser wing of the sphenoid completes it. This surface presents posteriorly and internally the optic foramen or canal; in front of this the transverse suture, between the sphenoid and frontal bones; anteriorly and externally a broad and deep depression, within the external angular process, for the lachrymal gland; and internally, behind the internal angular process, a superficial depression, or sometimes a rough surface, for the attachment of the trochlea of the superior oblique muscle. The *inferior wall*, or *floor*, is shorter than the superior, smooth, and nearly flat, inclined downwards and outwards, formed principally by the orbital plate of the maxillary bone, which covers the antrum maxillare; the malar bone completes it anteriorly, and the anterior small, triangular, orbital process of the palate bone posteriorly; it presents the sutures connecting these bones, and the infraorbital groove or canal leading nearly horizontally forwards and a little inwards; also near the anterior and inner border a slight ridge or roughness for the origin of the inferior oblique muscle. The *external side*, or *wall*, is the shortest; is formed in two-thirds by the sphenoid, and one-third by the malar bones; it leads obliquely forwards and outwards, and presents a suture and a small, irregular foramina, for the passage of nerves and vessels. The *internal side*, or *wall*, is larger than the last, and straight and parallel to that of the other orbit; is formed by the nasal process of the superior maxillary bone, the smooth posterior division of the unguis, the planum of the ethmoid, and the anterior clinoid process, and part of the side of the body of the sphenoid; it presents the several sutures uniting these bones, also, in that between the ethmoid and frontal, the two internal orbital holes, and anteriorly the deep fossa for the lachrymal sac, formed by the unguis and nasal process of the maxillary, from the lower part of which fossa the nasal canal, or duct, formed by the unguis, maxillary, and inferior spongy bones, leads downwards and backwards into the inferior meatus of the nose.

The *four angles* of the orbit are, first, the *superior* and *internal*, between the frontal, planum and unguis; second, the *superior* and *external*, between the frontal, malar, and sphenoid, corresponds to the foramen lacerum; third, the *inferior internal*, between the maxillary, planum, and unguis, is rounded off, and scarcely deserves the name of angle; fourth, the *inferior external*, between the malar and sphenoid, and the maxillary and palate bones, corresponds to the spheno-maxillary fissure, or inferior foramen lacerum. The *axis*, or central line leads obliquely from the apex forwards and outwards, and a little downwards. If, therefore, the axes of both orbits be produced, they will diverge considerably in front, but meet rapidly behind, and decussate at the back of the body of the sphenoid bone. These lines, therefore, are not parallel to the axes of the eyeballs, which lead more directly forwards, and are nearly horizontal, though not precisely so, their direction being a little inwards and forwards, and probably a little downwards, tending to converge towards the visual

object. As the eye, however, is in constant motion, the direction of its axis must as constantly vary. The *foramina* in the orbit are the optic, the lacerum superius, or sphenoidal fissure, the lacerum inferius, or spheno-maxillary fissure, and the anterior and posterior internal orbital. The *optic foramen* is placed in the anterior clinoid process, or between the two roots of the lesser wing of the sphenoid, not exactly in the apex of the orbit, but above and internal to this point: it is a flattened, oval canal, leading from the cavity backwards and inwards, parallel to the line of the axis, but internal and superior to it. If the optic canals of the opposite sides be supposed to be prolonged backwards, they would meet and decussate in the sella turcica. This foramen transmits the optic nerve, which is also flattened at this spot, and beneath it, where the foramen enlarges a little, the ophthalmic artery. The *superior foramen lacerum*, or *sphenoidal fissure*, is a long, narrow slit, triangular, wide internally, narrow externally, placed between the lesser and greater wings of the sphenoid bone, and closed externally in general by the frontal. Its larger inner end corresponds to the axis of the orbit, and transmits the third, fourth, ophthalmic division of the fifth and the sixth cerebral, and filaments of the sympathetic nerves. Beneath these, the ophthalmic vein escapes from the orbit to join the cavernous sinus. The external part of this foramen is closed by membrane, through which a small artery from the middle meningeal sometimes passes, and assists in supplying the lachrymal gland. The *inferior lacerated hole*, or *spheno-maxillary* fissure, is in the inferior external angle of the orbit, bounded by the sphenoid and malar bones externally, by the maxillary and palate internally, and in front by the malar; posteriorly it is open, and communicates with the last described opening, from which it differs in form, being narrow in the centre and wide at each extremity. It is occupied by fat, which can thus yield a little in the motions of the eyeball; it also transmits small nerves and vessels from the orbit to the zygomatic fossa. The *internal orbital foramina*, generally two, but sometimes three, or even four, are in the superior internal angle, in the suture between the planum and frontal bones: the *anterior* transmits the nasal twig of the ophthalmic nerve; the *posterior* the ethmoidal branch of the ophthalmic artery. The foramina in the outer wall are too minute and variable to receive distinct names, though occasionally one or two in the malar bone are of considerable size. The three openings in the circumference, viz., nasal duct, supra and infra-orbital foramina, have been already noticed.

Supercilia, or eyebrows, bound the superior eyelids; they correspond to the superciliary arches of the frontal bone, which partly cause their prominence; the latter also depends on a thick stratum of subcutaneous, adipose, and cellular tissue, together with the muscular fibres of the orbicularis palpebrarum, and the roots of the hairs. The hairs are mostly directed in a slanting manner outwards, and are placed in two rows; the superior directed downwards and outwards, the inferior upwards and outwards: and both rows converge in a median ridge, which causes a greater fulness, and an even, regular appearance. Internally the hairs are inclined inwards; and not unfrequently those of the opposite sides meet and decussate above the root of the nose. The eyebrows, however, are very variable as to length and prominence, also as to the size and direction of the hairs. These varieties, as well as the alteration in their form and position, induced by muscular action, exert a remarkable and well-known influence on the general expression of the countenance, and are even occasionally indicative of certain emotions of the mind. The eyebrows are of use in shading the eye from very strong light, and protecting it from particles of dust or fluid. They can be moved in three directions: elevated by the occipito-frontalis muscle, depressed by the orbicularis, and also depressed and adducted by the corrugators. (*See* Muscles of the Face, page 8.)

Palpebræ or *eyelids*, are the two movable, semilunar curtains, or cutaneous

folds, placed in front of each orbit, convex towards the surface and rounded, with horizontal wrinkles, smooth and concave towards the eye, and so exactly moulded to it, and arranged, as, when approximated, to conceal, and, when separated, to expose its anterior surface. The opening between them is named *palpebral fissure*, or *rima*. When closed, this fissure is a mere line, nearly transverse or horizontal, but a little curved, convex downwards, and higher externally than internally; it is inferior to the transverse axis of the eye, below the pupil, and cannot therefore be called "equator oculi." When the lids are opened, their margins are concave, and circumscribe an opening more or less elliptical, but very variable, and on the size of which the apparent magnitude of the eye very much depends. Its extremities are named *canthi*. The *outer canthus* is an acute, angular commissure, a little rounded, and about a quarter of an inch distant from the edge of the orbit, to which it is attached by a tense, fibrous membrane. The *inner canthus* extends from the inner extremity of the fissure for a short distance inwards towards the side of the nose, the edges being round or concave, and presents externally a small tubercle on each edge named *lachrymal papilla*, the point of which presents a minute but distinct foramen, *the punctum lachrymale*, which is the commencement of a small canal, *lachrymal duct*, which conveys the tears into the lachrymal sac, and thence into the nose. From between the puncta the palpebral fissure leads inwards, and expands into a small triangular space, *lacus lachrymalis*, in the centre of which is a red papilla, the *lachrymal caruncle*, between the upper and lower lachrymal duct. The upper eyelid is much deeper and more movable than the lower, and in sleep or death conceals the greater portion of the cornea. The free, or *ciliary margins* of the palpebræ, are thick, firm, and abrupt, cut off horizontally so as to meet closely by flat surfaces; the innermost edge being very slightly bevelled, as it corresponds to the row of Meibomian orifices, so that a very narrow groove or line exists between them. If the lids be examined when removed from the subject, and their edges placed in apposition on a convex surface, this arrangement may be observed. Many anatomists affirm that the opposed edge of each lid is cut off obliquely backwards towards the eye, so that when closed, a triangular canal is formed, the base being the surface of the eyeball; and that along this canal the tears are conducted inwards towards the puncta by the orbicular muscle acting in this direction. There is, however, no distinct canal, but at the most narrow line or groove, which is a little wider internally. Majendie totally denies the existence even of any groove. He conceives that the secretion during sleep passes along the palpebral sinuses, and that the puncta are perfectly capable of imbibing the fluid from these, and that ordinarily, and when awake, the secretion is supplied only in sufficient quantity to moisten the surfaces, and is then removed partly by evaporation and partly by absorption, and little or none passes by the puncta; and that these, therefore, are only designed to carry it off during sleep, or when supplied in unusual quantity. When the lids are separated, the margin of the upper may be observed to be bevelled upwards and backwards, but the edge of the lower is sloped in the contrary direction, that is, from the ocular margin downwards and forwards towards the skin, so that no canal can exist, such as described, when the lids are closed during sleep; during this time, also, the edges of the lids are not in close apposition, but the upper somewhat overlaps the lower.

The palpebræ are composed of skin, areolar tissue, an orbicular muscle, cartilage, or fibro-cartilage, with connecting fibrous membrane, glands, and mucous membrane. The upper lid also has a special levator muscle, and the free border of each is fringed with rows of hairs or cilia.

The *skin* is continuous with that of the forehead and cheek, and is thin, soft, and movable, in delicate persons almost semi-transparent, the blue veins shining through it, particularly in the upper lid, which is finer than the lower.

When the lids are apart it is thrown into semilunar, concentric folds, but, when closed, these are effaced. The *palpebral areolar tissue*, both subcutaneous and submucous, is very fine, loose, and reticular, and perfectly free from adipose structure; it admits of freedom of motion, and is very susceptible to serous infiltration.

The *cilia*, or *eyelashes*, are stiff, strong, curved hairs, placed in three or four rows on the cutaneous edge of the free margin; they are all curved or bent, the superior upwards, the inferior downwards, so that when the lids are closed the convexities of the cilia only touch, and, therefore, do not catch or entangle in each other. Those in the upper lid are longer, stronger, and more numerous than those in the lower; they first descend, and then bend upwards; the central cilia in each lid are longer than the lateral; they are absent at the inner canthus, that is, internal to the puncta, along the borders of the lacus lachrymalis; their bulbs or follicles are rather deep-seated, close to the tarsal cartilages, and beneath the orbicular muscle. The cilia defend the eye from the admission of particles of dust or other foreign bodies, and can also shade the eye from the impression of too strong light. Along the posterior or ocular edge of the free border of each palpebra is a row of minute foramina, the orifices of the *Meibomian glands*, to be noticed presently. That portion of the free margin of each lid, surrounding the lacus and internal to the punctum, is thin, round, and free from hairs and Meibomian follicles; these are transferred to the inclosed caruncle.

The *orbicular*, or *sphincter muscle*, is the next tissue in the palpebræ; it also extends over the circumference of the orbit; superiorly into the supercilia, and inferiorly upon the cheeks. In these latter situations its fibres are red and circular; on each curtain they are thin, scattered, and elliptical; but near the ciliary edge of each they are collected into a thick fasciculus; the external or orbital fasciculi are red, but the palpebral and ciliary are as pale as the involuntary muscular fibres of the alimentary canal. All the fibres are attached to the internal tendon, named "tendo oculi," or more probably, *tendo palpebrarum*. This tendon is inserted internally into the nasal process of the maxillary bone, thence it is directed outwards in front of the lachrymal sac, above its centre, and bifurcates. Each band incloses a lachrymal duct, and is inserted into the inner extremity of each tarsal cartilage beneath the punctum. From the upper and lower margins of the tendon a strong fascia extends over the sac, binds it down in the lachrymal fossa, is inserted into the maxillary and unguis bones, and is continuous with the periosteum: inferiorly this fascia can be traced obliquely outwards, as far as the origin of the inferior oblique muscle of the orbit.

The *orbicularis palpebrarum* muscle closes the lids as a sphincter, partially or completely, by depressing the upper one considerably, and very slightly raising the lower, at the same time it draws the latter a little horizontally inwards; it also presses the lids against the globe, protects and supports the latter, compresses the palpebral sinuses, and directs the lachrymal secretion into the puncta. Its frequent and rapid motion, as in winking, cleans and polishes the surface of the cornea, and by partially closing the curtains, and approximating the eyelashes, it shades the eye from too bright light, and thus serves as an external iris and pupil; its thick, ciliary fasciculus strengthens the edges of the lids, supports the ciliary bulbs, and expresses the Meibomian secretion.

The *palpebral*, or *tarsal cartilages*, with their fibro-membraneous connection to the base of the orbit, are seen on removing the orbicular muscle and some fine areolar tissue. Each tarsal cartilage, or fibro-cartilage, is a thin, elastic plate, covered by and connected to the orbicular muscle on its superficial or convex surface, and lined by mucous membrane and follicles on its ocular or concave surface. The upper cartilage is between the orbicular and levator palpebræ muscles; it is semilunar, broad in the middle, narrow and pointed

towards either end, and much larger and stronger than the lower, which is merely a narrow band, and more fibrous than cartilaginous. The ciliary, or free margin of each is abrupt, nearly horizontal, or slightly bevelled, as before-mentioned, and is very thick, which causes the firmness of these edges of the lids. The orbital, or fixed edge of each, is thin, and attached to the base of the orbit by a fibrous expansion, named *broad ligaments of the tarsus*. These are not true ligaments, but only dense fibrous structure, continuous with the periosteum at the base of the orbit: it is strong and tense in the outer half of each lid, but internally, especially in the upper, it becomes weak and filamentous: at the external canthus it is very strong and cord-like; extending inwards from the edge of the malar bone it divides into two bands, which partly decussate, and are inserted into the extremities of each cartilage. The tendo oculi also answers as a ligament to these cartilages at the inner canthus. Connected to the deep surface of the broad ligament, in the upper lid, is the aponeurosis of the elevator muscle of the latter, and which is expanded between this and the superior palpebral sinus of the conjunctiva, as will be explained presently. The tarsal cartilages, thus retained in their situation, enjoy sufficient freedom of motion to admit of being rapidly moved over the front of the eye; their peculiar structure preserves the form of the palpebræ, and imparts to them sufficient strength and firmness, pliancy and elasticity.

The *Meibomian glands*, or *follicles*, can be seen distinctly when the palpebræ are everted, but may also be exposed from the cutaneous surface; they appear as pale, yellow, long, parallel ducts, but slightly tortuous, leading from the free margin of each lid, where they open in a row of minute pores, behind the cilia, visible with a lens, along the ocular surface of the cartilage, imbedded in grooves in the latter, and covered by the mucous membrane, through which they never project in their normal state. They are longer and more numerous in the upper than in the lower lid; each gland, or sebaceous follicle, is an inflection of the mucous membrane in a tortuous and coiled tubular form, ending in a cæcal extremity, and surrounded by minute follicles, which are cæcal diverticula, opening into it. These secrete an unctuous fluid, which lubricates the edges of the lids and the cilia, prevents their friction and adhesion when closed, opposes the entrance of minute foreign bodies, such as particles of dust, and also prevents the overflow of the tears when the latter are secreted in moderate quantity. In the dead subject the secretion has solidified, and can be squeezed out like fine, white, twisted threads.

The *conjunctiva*, or *internal integument of the palpebræ*, lines these curtains and connects them to the eye; hence its name. It covers the anterior third of the globe, lines the numerous Meibomian follicles, is prolonged from within the upper eyelid, near the external canthus, through the eight or ten excretory vessels of the lachrymal gland, into that organ; forms a fold or duplicature at the inner canthus, and is continued through the puncta into the lachrymal ducts, sac, and nasal duct, into the nose, where it becomes continuous with the gastro-pulmonary mucous surface. Though, strictly speaking, it is a mucous membrane, some portions of it are so modified as to bear but little resemblance to that tissue. Its connections and arrangement deserve particular attention. At the free edge of each palpebra it is continuous with the skin; within the superior lid it ascends, adheres to the cartilage, rises above it into a *cul de sac*, the *superior palpebral sinus*, which is loosely connected to the cellular and adipose tissue within and beneath the rim of the orbit, and is then reflected on the forepart of the sclerotic coat of the eye; to this it is connected by areolar tissue, which is loose externally, and often the seat of serous and sanguineous effusion: it becomes more close and tense near the cornea; over the latter it is continued, but so delicate and so adherent to it that it cannot be separated by dissection for any considerable extent

without previous maceration, and is so fine and transparent, and devoid of vessels, that its existence has been doubted by some and denied by others. From the lower part of the sclerotic, to which it is loosely connected, as above, it is reflected on the inner surface of the inferior lid, forming another loose *cul de sac*, the *inferior palpebral sinus*, similar to, but smaller than the superior. These folds admit of the free motion of the lids and of the eye-ball. It then lines the lower lid, and is continuous with the skin at its margin; at the outer canthus it also forms a *cul de sac*, behind the external palpebral or tarsal ligament; internally, at the inner canthus, it forms a vertical, semilunar fold, concave outwards, towards the cornea, named *plica semilunaris*. This fold is extremely vascular, and contains a thin plate of dense tissue, like fibro-cartilage. It may be considered as rudimental of the membrana nictitans, as seen in most quadrupeds, or of the third eyelid in birds. When the eye is rotated inwards it becomes very distinct, but it is effaced when the former rolls outwards.

The *caruncula lachrymalis* is a small, irregular eminence, of a lively red color, plump and full in health, but pale and flaccid in sickness, placed in the lacus, at the inner canthus of the internal palpebral fissure, internal to the plica lunaris, and between the lachrymal ducts. It consists of dense fibro-areolar tissue around a number of minute follicles, which secrete a sebaceous secretion that often accumulates in this corner, also of the bulbs of several minute hairs; these are all covered by the conjunctiva, which is perforated with minute pores. It has some analogy to the gland of Harder, in the third eyelid of birds; both, however, co-exist in some quadrupeds. The conjunctiva is thicker, more vascular, and adherent in its tarsal than in its sclerotic portion; by means of the palpebral sinuses or reflections, and the plica lunaris, it completely cuts off all communication with the orbit; and when the lids are closed we may consider it as forming almost a short sac, like that of a serous membrane, or bounding a space, named *oculo-palpebral*, which is formed in front by the eyelids, behind by the eye, and circumscribed all around by the reflections of the membrane, which separate it from the cavity of the orbit. It is constantly moistened with the twofold secretion, partly from its own vessels and follicles, and partly from the lachrymal gland. It is exquisitely sensible in some situations, especially when any foreign substance is interposed between its palpebral and ocular surfaces; it receives its nerves from the ophthalmic, a branch of the ganglionic or sentient division of the fifth cerebral. Its arteries are derived from the ophthalmic, the labial, and transverse facial.

The intimate structure of the conjunctiva has been found, by the aid of the microscope, to be analogous to that of mucous membrane generally; it consists of a fine epithelial lamina and a chorion, with a very vascular or papillary surface. The existence of epithelium was formerly denied, but of late years it has been established by the concurring observations of different anatomists. It consists of minute rhomboidal scales, or flattened cells, closely connected, each with its dark central nucleus. In some animals pigment granules are diffused among the deeper cells in different patches. In some chronic diseases of the lids, with ectropium, the epithelium occasionally becomes developed; and in certain forms of very prominent staphyloma of the cornea the latter also becomes covered with a distinct epithelium or cuticle. The chorion, with its papillary layer, is best developed on the palpebral portion of the conjunctiva; it adheres so closely to the cartilage as to resemble a fibro-mucous tissue; it has all the characters of the other mucous membranes. These commence a little behind the inner sharp edge of each ciliary margin. The papillary lamina is very vascular on the inner side of each lid, and, when viewed through a lens, presents numerous red papillary grains; these probably are mucous follicles. This lamina is less developed on the sclerotic con-

junctiva, and cannot be demonstrated on the corneal portion. In certain forms of chronic ophthalmia this papillary surface of the palpebræ is very prone to thickening, and to assume a granular appearance. The perfect transparency of the cornea, the total absence of red vessels, its density, and the difficulty of detaching from it any thing like a continuous membraneous structure, has led some to deny the existence of the conjunctiva in front of the eye; modern anatomists, however, have determined this point affirmatively. If the recent cornea be gently scratched or torn with a needle, portions of soft membrane can be raised, similar to the surrounding tissue in all respects save vascularity, and the compact and dense cornea may be seen smooth and uninjured. Superficial wounds and injuries during life exhibit the same phenomena; and, if the eye be allowed to remain in water for twenty-four or thirty-six hours, a distinct membrane can be turned off the entire cornea, and its continuity with the surrounding conjunctiva seen, a very intimate adhesion existing at the circumference of the former. This covering of the cornea, so distinct and different from its proper substance, appears under the microscope composed of two laminæ: the more superficial is epithelial and non-vascular; the deeper layer is loose and areolar, and is a modification of the chorion and papillary structure. In and beneath this the vessels from the sclerotic conjunctiva pass; these are very minute and colorless, and most difficult to inject; they have, however, been filled, and have been minutely described by Rōmer and Müller. Morbid and comparative anatomy afford additional evidence on this point. In chronic ophthalmia red vessels occasionally extend from the circumference of the cornea, over its surface, and render the latter distinctly vascular and opaque. Pustules also form upon the cornea similar to those on the sclerotic conjunctiva; and in very prominent staphyloma, as before remarked, the cornea becomes coated with a distinct cuticle or epithelium. In some of the subterranean mammalia, in some reptiles and fish, a thin integument passes over the front of the eye and of the cornea, and can be easily detached by dissection: in serpents also, during the well-known process of casting their skin, the cuticle is detached from the forepart of the eyes along with that from the head. This fact, however, though commonly adduced in support of the anatomical position we are here maintaining, does not afford any such proof, inasmuch as, according to J. Cloquet (*see Mem. sur les Voies Lachrys dans les Serpens*), there exists beneath this transparent cutaneous frame a conjunctival lining, which is also reflected over the forepart of the eye, so as to form a true oculo-palpebral chamber, communicating with the mouth by a small palatine duct; and when the animal casts its coat it only sheds the palpebral epidermis, but not the conjunctiva, and neither is the oculo-palpebral space opened during that process.

The *lachrymal apparatus* consists of the lachrymal gland and its excretory ducts, the two puncta lachrymalia, the lachrymal canals leading from each into the lachrymal sac, and, lastly, the nasal duct, leading from the latter into the nose.

The *lachrymal gland* is of the conglomerate or compound order of secreting organs; of a pale reddish color, surrounded by a cellular capsule, situated to the upper and outer aspect of the globe of the eye, a position from which its secretion can most effectually flow over the anterior surface of the globe; it consists of two lobes, a superior or orbital, and an inferior or palpebral. The orbital is the larger lobe, is lodged in the fossa of the frontal bone, behind and within the external angular process, of an oval form, about half an inch in breadth from before backwards, and three-quarters of an inch in length from within outwards; its upper surface is convex, and attached to the periosteum of the orbit; its lower is a little concave, and in relation with the globe and with the external and superior recti muscles; its anterior border corre-

sponds to the superciliary arch and to the tarsal ligament; its vessels and nerves enter its posterior margin and inferior surface.

The inferior or palpebral lobe is only partially separated from the former, is smaller and thinner, and inclosed in a more dense capsule; it extends in the upper eyelid as far as the outer part of the orbital margin of the cartilage, is behind the fibrous ligament of the latter, and rests upon the superior palpebral sinus of the conjunctiva. If the lid be fully everted, it can be seen through the membrane. Six or eight delicate ducts descend nearly parallel from the gland, and open opposite to its lower border by separate orifices, near each other and in a row, on the inner surface of the upper lid, commencing about half an inch from the outer canthus, and a little above the upper margin of the cartilage. These ducts are very difficult to detect, and for a long time were unnoticed by anatomists. They can be well seen in the dog. This organ is the source of the tears which are continually supplied in sufficient quantity to moisten the surface of the lids and of the eyeball, and, mingling with the more viscid secretion of the mucous membrane, are then partly evaporated, and, according to Majendie, partly absorbed; the remainder are conducted, by the constant motion of the palpebræ, inwards along the palpebral sinuses, and partly along the narrow channel between the ciliary margins of the tarsi and the globe, to the puncta lachrymalia. The *lachrymal secretion* consists of water and one per cent. of muriate of soda, and a yellow extractive matter. The tears are so abundantly afforded, when the entrance of any foreign body excites irritation, or under certain mental emotions, as to flow over the margins of the palbebræ and of the lacus lachrymalis upon the cheek.

The *puncta lachrymalia* are the two small holes in the cartilaginous projections, named lachrymal papillæ; they are always open, and visible to the naked eye, at the inner extremity of the ciliary margin of each cartilage, at the outer extremity of the "lacus," just where the internal fissure commences, and about two lines distant from the inner canthus; each opening is much larger than any of the Meibomian follicles, and will admit a bristle or moderately-sized pin. They both have an aspect outwards and backwards towards the surface of the eye and towards the groove, between the closed tarsal cartilages; the upper one also looks a little downwards; and the lower one, which is more prominent and a little more external, upwards; they are separated by the caruncula, and each leads into the following.

The *lachrymal canals* are two, a superior and inferior. The superior is longer and more curved; from the punctum it first ascends, then bends abruptly inwards and downwards, and enters the anterior and outer or orbital side of the sac. The lower canal first descends a little, then also bends abruptly inwards, ascends a little, runs close to the upper, and opens into the sac, so near to it that, at first view, they appear to end in common; they generally, however, open distinctly behind the tendo oculi: each canal is lined by mucous membrane, and covered by a fibrous tunic derived from the bifurcation of the orbicularis palpebrarum and tensor tarsi tendons; they are each dense and elastic, whereby their calibre is preserved from collapse, and a little larger at their angles than at either extremity; they bound the lacus and lachrymal caruncle. When the lids are closed their course is more transverse or horizontal, and their angles more acute; when the upper lid is raised the direction of the superior duct becomes more oblique and less triangular. Depressing the lower lid has the same effect on the inferior duct; the tears are carried into the puncta, and forced along these canals partly by the absorbing power of their capillary openings, and partly by the adducting power of the orbicular muscle, and of the tensor tarsi, or the muscle of Horner.

The *lachrymal sac* is the upper extremity, or oval *cul de sac*, of the nasal duct, distinguished from it externally only by a slight constriction, and inter-

nally by an imperfect valve, or semilunar fold; it is deeply imbedded in an osseous fossa, at the inner and anterior part of the orbit, bounded internally by the nasal process of the maxillary bone, and posteriorly by the anterior concavity of the unguis; open anteriorly towards the surface, also externally towards the orbit, but is covered and bound down in these aspects by the tendo oculi, which crosses it transversely a little below its *cul de sac*, and above its centre, also by a strong and very tense aponeurosis, derived from the margins of this tendon, and which are inserted into the bony margins of the fossa; it is also covered by the skin, and the angular vein and artery are superficial to it, and a little to its nasal side. The tensor tarsi, which may be considered as an appendix to the orbicular muscle, is on its external or orbital aspect. This muscle arises from the vertical ridge of the unguis, and passes forwards and outwards behind the tendo oculi.

Open the sac, and the interior will be seen, soft and of a pale color, usually filled with adhesive mucus; its *cul de sac* above, its continuity with the nasal duct below, and sometimes a small semilunar fold between them; also, on its anterior and outer wall, the two orifices of the lachrymal canals, near its centre, from above downwards. The sac is situated opposite the middle meatus of the nose, and, if the unguis be perforated, a probe may be passed into this region, or perhaps into the infundibulum. This fibro-mucous sac receives the lachrymal secretions from the small ducts, and transmits them to the nose. The tensor tarsi and orbicular muscles may adduct these ducts, and urge their contents into the sac; how far they can also compress the latter is doubtful, from the strength and tension of the intervening aponeurosis.

The *nasal duct* leads from the sac obliquely downwards, backwards, and outwards, and opens into the anterior part of the outer side of the roof of the lower meatus of the nose, under cover of the inferior turbinated bone; it is about three-fourths of an inch long, is a little curved, convex backwards, flattened at the sides, and wider about the centre than at either extremity; separated from the antrum by a thin but strong bony lamella, and is on the outer side of the middle meatus and inferior spongy bone. It is a fibro-mucous duct, inclosed in and rather loosely adherent to the osseous canal, formed by the maxillary, unguis, and inferior spongy bones. The membraneous portion is elongated inferiorly beyond the osseous, in the form of a narrow, oblique process or valve, but very variable in extent. Whether this or the superior semilunar fold can act as such is doubtful, but is rendered probable by the fact that air cannot be forced by any effort during life from the nares into the sac, or through the lachrymal ducts.

The student may next examine the muscles, nerves, and vessels of the orbit. The roof of the cavity having been carefully raised, the periosteum usually separates from it, and remains attached to the parts beneath and to the ligament of the upper eyelid; it appears continuous with the dura mater. As this membrane enters the apex of the orbit by the optic and superior lacerated foramina, it divides into two laminæ; one joins or becomes the periosteum, the other is continued as a sheath on the several nerves. At the optic foramen this arrangement is very evident; it forms a tubular sheath for the optic nerve, and joins the sclerotic coat of the eye. Divide and raise the periosteum; three nerves are seen, the frontal in the middle, the lachrymal externally, and the trochleator internally; the latter rests on the superior oblique, the frontal on the levator palpebræ and superior rectus, and the lachrymal on the external rectus muscle. Small vessels accompany these nerves. The orbit contains seven muscles and several nerves; the interstices are filled with a quantity of soft adipose substance; this must be carefully drawn out with the forceps, and snipped off with the scissors. The muscles are the levator palpebræ, four recti, and two oblique; all these, except the inferior oblique, arise near or around the apex of the cavity, and thence diverge to their re-

spective insertions. Three are situated above the optic nerve, viz., levator palpebræ, superior oblique, and superior rectus; two are beneath it, the inferior rectus and inferior oblique; and one is at either side, the internal and external rectus.

The *levator palpebræ superioris* is one of the largest and highest muscles in this region, being immediately beneath the periosteum. Thin, flat, and triangular, it *arises* narrow by radiated, tendinous fibres from the upper or anterior border of the foramen opticum, and from the fibrous sheath of the optic nerve; passes forwards, at first a little upwards and outwards, in the axis of the orbit, becomes broad, thin, and fleshy, and anteriorly bends downwards in front of the eye, and ends in a thin, fibro-membraneous expansion, which is *inserted* into the convex border of the superior tarsal cartilage, and through the medium of a thin fascia, which covers and incloses the muscle, into the convexity of the superior palpebral sinus of the conjunctiva and subconjunctival fascia, behind or beneath the broad ligament of the tarsus. *Use:* to elevate the upper eyelid; its also retracts its cartilage beneath the edge of the orbit; at the same time the eye is slightly protruded either by the swelling and fulness of the muscle within the orbit, or by the partial withdrawal of the compression of the lid in front; and at the same moment, as remarked by Sir C. Bell, the lower lid is depressed by slipping off the convexity of the protruding globe, and thus the forepart of the organ becomes fully exposed, as in staring. It lies above and rather external to the superior rectus; the trochleator nerve crosses over its origin, also the ophthalmic, the frontal division of which, and its branches, continue on its upper surface and nearly parallel to it. A branch of the third, or the motor nerve, is distributed to its inferior or ocular surface. When this nerve and muscle are in a state of paralysis the upper lid droops down in front of the eye—an affection named "ptosis." The inferior lid is elevated by the orbicularis palpebrarum, and has no special muscle; neither has it any depressor. In most birds the lower lid chiefly covers the eye during sleep, and possesses a distinct depressor muscle.

Fig. 72.

The six following muscles are proper to the eyeball; four are called *straight*, and two *oblique;* by their several actions the varied motions of the eyeball are performed. We shall first examine their anatomical relations, and afterwards consider their actions individually and combined. The four muscles named *recti* are by no means straight, for they all converge towards the apex of the orbit, where they arise, and as they pass forwards they diverge so as to bound a sort of pyramidal space inclosing a greater part of the globe of the eye, the optic nerve, some smaller nerves and vessels, a quantity of adipose substance, and a strong fascia; and, lastly, each of these

* The muscles of the orbit of the left side. 1. 1. Portion of the frontal bone, forming part of the roof of the orbit. 2. Portion of the sphenoid bone. 3. External pterygoid plate of sphenoid bone. 4. The ossa nasi. 5. The globe of the eye. 6. The external rectus muscle, with its two heads of origin. 7. The inferior rectus. 8. The superior rectus. 9. The superior oblique muscle of the eye. 10. The cartilaginous pulley of the superior oblique. 11. The reflected tendon of same muscle. 12. The inferior oblique muscle. 13. The internal rectus. 14. The levator palpebræ superioris.

muscles bends a little around the forepart of the globe to reach its insertion. Each of the recti, therefore, must take an oblique or slanting course, and must represent a curve concave towards the eye, convex forwards and outwards towards the orbit; they are each of a triangular form, the apex behind, the base before; the superior is the thinnest and smallest, the external the longest, and the internal is the shortest and thickest; they all terminate in front in thin tendons, which extend to within a few lines of the circumference of the cornea. These tendinous expansions have long received the name of "tunica albuginea," a term which is incorrect, as their margins do not coalesce, being only connected together by an investing fascia.

Rectus superior, or *levator oculi, arises*, small and tendinous, beneath and in common with the levator palpebræ, from the root of the lesser wing of the sphenoid bone, between the sphenoidal fissure and the optic foramen; also from the upper margin of the latter, or rather in the angle between the orbital periosteum and the fibrous sheath of the optic nerve. It soon becomes fleshy, thin, and flat, about half an inch broad; proceeds forwards and a very little outwards over the optic nerve and upper part of the globe; separated from these by some fat, also by a fascia (ocular fascia), to be noticed presently. About its anterior third it ends in a thin tendon, composed of bright parallel fibres, which pass through this fascia, the latter being continued as a sheath over the muscles; the tendon then bends a little downwards on the anterior part of the eye, and is *inserted* into the sclerotic, about four lines, or the third of an inch, behind the cornea; the line of insertion is a little convex, so that the central fibres advance about a line further forwards. The levator palpebræ covers the greater portion of this muscle; a part of it appears anteriorly between it and the superior oblique; beneath it are the upper division of the third, the nasal, and the optic nerves, also the ophthalmic artery and the eyeball. A fine areolar tissue, often resembling a small synovial sac, lies beneath the tendon of this as well as of the other recti as they bend towards the forepart of the eye to their insertion. This must facilitate the action of these muscles and the motions of the eyeball.

Rectus internus, or *adductor oculi, arises*, in common with the last, from the optic sheath, also from a strong, semicircular, fibrous tissue, *tendon* or *ligament of Zinn*, which is attached to the lower or posterior margin of the optic foramen, and to a depression on the inner side of the sphenoidal fissure; proceeds nearly horizontally forwards, ends in a tendon which pierces the ocular fascia; is *inserted* in the same manner as the last, and between it and the inferior rectus, into the sclerotic, about three lines behind the cornea, by its central fibres; its superior edge is distant four and its inferior edge five lines (Lucas).

Rectus inferior, or *depressor oculi, arises* from the ligament of Zinn, in common with the last and with the lower head of the external rectus, passes forwards and downwards, ends in a tendon which is disposed similarly to the others, and is *inserted* into the sclerotic about the same distance from the cornea as that of the superior rectus, to which it is directly opposite; it lies beneath the optic nerve and the globe, is separated from the floor of the orbit by the inferior oblique muscle and much adipose tissue.

Rectus externus, or *abductoc oculi*, is the longest and most oblique of the recti; *arises* by two very distinct origins, an inferior from the ligament of Zinn, in common with the two last muscles, and a superior or external from the optic sheath and margin of the optic foramen, between it and the sphenoidal fissure, in common with the superior rectus; a tendinous arch connects these heads, from which additional fibres arise; between these origins pass the third, the nasal, and the sixth nerves, and sometimes the ophthalmic vein. The muscle proceeds very obliquely forwards and outwards, and its tendon is inserted into the sclerotic in the same manner as those of the other recti, but

does not approach so close to the cornea, its central fibres being nearly five lines, and its upper and lower six lines distant from it. Its external surface corresponds to the wall of the orbit, and to the lachrymal gland anteriorly; the lenticular ganglion, ciliary nerves, vessels, and fascia separate it from the optic nerve and the globe; the sixth nerve is wholly distributed to its ocular surface.

The recti muscles are all connected together by a cellulo-fibrous tissue, which may be named *ocular fascia*. Though not very thick or strong, it is tough, flocculent, and difficult to remove; it covers these muscles as far back as their origin, and is continued anteriorly over their tendons, but of a finer and denser tissue, nearly to the circumference of the cornea, and beneath the conjunctiva, on the ocular surface of which it is reflected outwards towards either canthus of the orbit, and forwards to join the fibro-ligamentous structure and the cartilages of the palpebræ. It is also prolonged as a thick sheath round the trochleator tendon, as far as its pulley, to which it is connected, and around the inferior oblique to its origin. This fascia so far seems to connect and retain all these muscles and tendons in their proper relative situations, both to each other and to the eyeball; but it has a still further and more interesting relation, for it is continued beneath the four recti, forming for each a perfect sheath and a non-adherent envelope for the posterior part of the eyeball. To expose this portion, separate the margins of two or three of these muscles; divide them about their centre, avoiding any injury to the subjacent fascia; raise the divided muscles, one portion backwards, the other forwards. This fascia is then seen to pass backwards as far as the optic nerve, in the sheath of which it is lost, and forwards as far as the tendons of the recti and obliqui, round each of which it is prolonged in an infundibuliform manner to the external surface of their fleshy fibres, on which it is expanded, as before stated, while a thinner lamina is also continued forwards upon the conjunctiva, and ultimately to the eyelids. This membrane covers the ball very loosely, so that the latter can move or rotate freely within it. This will be better seen if the fascia be divided longitudinally, or from before backwards; it is attached to the sclerotic coat by areolar or serous cellular tissue, containing the ciliary vessels and nerves, and a little adipose substance. This deep portion of the ocular fascia is thick, strong, and elastic, but variable in these respects; it is of a yellowish white color, and appears composed of areolar and yellow elastic tissue, rather than the white fibrous basis of ordinary fasciæ or aponeurosis. When the divided margins of it are held asunder, its prolongations round the six tendons are seen, presenting internally smooth spaces around each; these are not, however, foramina, or perforations in the fascia, but merely the inner extremities of the funnel-shaped processes continued from this deeper portion to the superficial surface of the muscles. This fascia serves as a loose covering for the eye, within which it can rotate freely, and is protected by it from the friction of the surrounding muscles; also, by its attachment to the optic nerve behind, and to the eyelids and orbit in front, it in some measure contributes to support and suspend the organ in this region. Although this fascia has long been familiar to every practical anatomist, it has only been noticed by modern writers. Tenon, I believe, has first described it (*Tenon, sur une nouvelle tunique de l'œil, Mem. et Observ, sur l'Anatomie*). Dalrymple, in the year 1834, has also noticed it very correctly in his Anatomy of the Eye (page 248); but Malgaigne, in 1838, in his *Anatomie Chirurg.*, has described it with anatomical correctness (page 375), and names it, from its peculiar whitish appearance, *albugineal membrane;* and again, in his *Manuel de Medecin Operatoire* (page 376), points out the necessity of dividing, not merely the subconjunctival portion of this membrane when cutting across the tendon of the internal rectus for the relief of strabismus, but also the deep or the ocular layer, which forms

the posterior part of the sheath of the muscle; and he states that, if the tendon be divided close to its insertion, the superficial lamina only of this fascia will be cut through, and the operation will prove of no avail, and, therefore the cutting instrument should pass behind the rectus, near its fleshy portion, so as to divide this deeper fascia. This membrane has been also named *ocular, subconjunctival fascia, fibrous capsule of the eye,* &c. Mr. J. M. Ferral, in 1841, has described it as a *new structure in the orbit,* and named it *tunica vaginalis oculi* (Dub. Jour. of Med. Sci., July, 1841, p. 329). For the exposure of it he directs the following dissection: "Divide both palpebræ vertically, turn the separated portions backwards towards the forehead and cheek, and fix them by hooks; divide the conjunctiva at its angles of reflection, from the eyelids to the ball, and separate the edges. We expose a distinct fibrous tunic, of a yellowish white color, continuous in front with the posterior margin of the tarsal cartilage, and extending backwards to the apex of the orbit, where its consistence is less marked. This dissection may be made with the probe or director, gently breaking the cellular connections between the ball and this *new organ.* Its color differs from that of its external surface, being perfectly smooth where the eye glides over it in its movements. The muscular substance of the recti is nowhere visible, as they lay outside this fascia, which insulates and protects the eye in the most perfect manner. In the concavity of this tunic, and half an inch posterior to its orbital or anterior margin, are found six well-defined openings, through which the tendons of the muscles emerge in passing to the sclerotic, and over which they play, as over pulleys, in their course; the tendons are loosely connected to the edges of those apertures by fine cellular tissue, which oppose no obstacle to their gliding motion." Much of the appearance, however, last described, arises from the tense and constrained position in which the tissues are held, by the hooks in the first instance fastening them in front. To this fascia Mr. Ferral ascribes more mechanical uses than we have stated above, and with which we cannot entirely concur; he conceives it is capable, first of protecting the eyeball from the pressure of the recti muscles during their action; second, of preventing these muscles retracting the eye; third, that their rotatory influence is secured and facilitated by passing through what he describes as distinct trochlear openings in the fascia, and that their force acquires thereby a new direction, that is, they act as if they arose from the sides, and not from the apex of the orbit; pathologically, he conceives that certain cases of disease within the orbit, accompanied by protrusion of the eyeball, are to be explained by reference to this tunic.

Use.—From the manner in which the four recti muscles are arranged, converging behind, expanding and diverging before, connected together by fasciæ, embracing the eye as it were by a conical muscular capsule, but separated from immediate contact with it by the elastic albugineal membrane, or ocular fascia, and from their tendinous expansions being continued over the forepart of the globe, as far nearly as the cornea, they must possess considerable power as rotators of the spherical body, and can turn the cornea or the pupil in almost every direction with the slightest possible muscular effort, and with the greatest accuracy and precision. Their combined actions, even little more than their mere tonic state, can maintain it fixed steadily upon the object, and individually they can rotate it in different directions. The superior and inferior can turn it on its transverse axis, that is, on an imaginary line passing through it from the temple towards the nose: the superior rectus, by rotating the ball on this axis, will turn the cornea and pupil upwards, the inferior downwards; hence the former is named levator, or attollens, the latter depressor oculi; corneæ would be a more suitable term, for the whole eye is neither raised nor depressed, but merely rotated. In like manner the internal and external recti rotate the organ on its vertical axis, that is, on a line supposed

to pass through the centre of the globe from the roof to the floor of the orbit; the internal rectus, by rotating the eye on this axis, turns the cornea and pupil inwards, the external outwards; hence the former is called adductor, the latter abductor oculi. The extent to which these several motions can be carried varies in different individuals. The rotation on the vertical axis, whereby the cornea moves horizontally inwards towards the nose, and outwards towards the temple, appears more extended than the rotations on the transverse axis, or those of the cornea upwards and downwards; in neither case, however, can the eye be rotated to such an extent that the cornea can become concealed by the lids. The recti have not the power of rolling the eye, or rotating it on its long or antero-posterior axis, that is, a line supposed to pass through the centre of the cornea and pupil to the back part of the orbit. This rolling or rotatory motion is most probably effected by the oblique muscles, to be considered presently. In addition to rotation in the four distinct directions just mentioned, the cornea can also be directed in the intermediate or diagonal lines; thus the superior and internal recti can direct it upwards and inwards, the superior and external upwards and outwards, the inferior and internal downwards and inwards, and the inferior and external downwards and outwards. By the rapid succession of these several actions the organ may also undergo a sort of circumductory motion, different from rotation, or rolling on the antero-posterior axis. In the former, the centre of the cornea describes a portion of a circle; whereas in rotation on the antero-posterior axis the centre of the cornea remains fixed, and forms the anterior extremity of the imaginary axis round which the circumference of the cornea revolves. It has been maintained by some that the combined action of the four recti can also retract the eye to a greater depth in the orbit, a change which is effected in many of the lower animals by a distinct muscle, confined to the posterior part of the orbit and of the eye, named the "retrahens oculi;" there is no proof, however, that these muscles can, or that they ever do, exert this power in the human subject. To accomplish it, the four must combine in one strong and simultaneous contraction, which is contrary to their usual mode of action, as in general only one or two act at any one time; neither is there any empty space within which the eye can be easily drawn, as the orbit is exactly filled by its contents, which, though yielding, are elastic; the connection of the globe anteriorly to the palpebræ and canthi of the orbit serves to keep it forward, and the oblique muscles can also afford opposition to any retracting force. Another opinion also, formerly prevalent among anatomists, and still entertained by some, but one equally destitute of proof, is that the simultaneous contraction of these four muscles can compress the eyeball so as to alter its shape and elongate its antero-posterior diameter, and thus contribute to the adaptation of its optical apparatus to vision at different distances. The recti muscles have been thought by some to denote peculiar passions or emotions of the mind, and have accordingly received these fanciful names: the superior, *superbus* or *mirator;* the inferior, *humilis;* the external, *indignatorius;* and the internal, *amatorius* or *bibitorius*, from the eyes being turned inwards in drinking.

The oblique muscles are two in number, the superior and inferior.

The *obliquus superior*, or trochleator, is long and slender, and rather round, situated at the upper and inner part of the orbit; *arises*, by a delicate tendon from the sheath of the optic nerve and from the inner margin of the optic foramen, on the inner side of the levator palpebræ, and between the superior and internal recti; it passes forwards and a little upwards and inwards along the os planum, parallel to the suture between it and the frontal; ends in a round tendon which passes through the cartilaginous pulley, attached by a movable fibrous ligament to a depression behind the inner angle of the os frontis, and lined by a synovial membrane, which admits of the free play of

the tendon; the latter is then reflected backwards, outwards, and a little downwards, inclosed in a membraneous sheath from the ocular fascia, over the internal rectus, and beneath the superior rectus, that is, between it and the globe, and, becoming broad and thin, is *inserted* into the posterior part of the sclerotic coat, between the superior and external recti, and nearly midway between the cornea and the entrance of the optic nerve, or nearly on a level with, but a little behind, the transverse axis of the eye, and external to the vertical. The fourth nerve is distributed to the upper or orbital surface of this muscle; the nasal nerve and ophthalmic artery are beneath it. The pulley is generally a semicircular cartilage, its two cornua being attached by short ligaments to the bone. In some instances there is a bony pulley, like the hamular process on the pterygoid plate of the sphenoid. As this pulley changes the direction of the tendon, the action of the muscle is directed towards this point; and in considering the use of the muscle we may regard it as arising from the pulley, a point nearly vertically opposite to the origin of the inferior oblique muscle.

The *obliquus inferior* is the shortest of the group, and the only one that is not connected to the apex of the cavity, being situated at the anterior and inferior part of the orbit, behind the lower eyelid; *arises* tendinous from a rough ridge, behind or within the orbital margin of the superior maxillary bone, above the infraorbital foramen, and external to the lachrymal sac; it soon forms a flat, thin muscle, which ascends obliquely outwards and backwards, curving in a semicircular manner beneath the inferior rectus and the eyeball, then ends in a broad, thin tendon, which ascends between the eye and the external rectus, and is *inserted* into the posterior external part of the sclerotic, between the external and superior recti, near the expansion of the superior oblique, and a little behind the transverse axis, and of course external to the vertical axis of the eyeball. This muscle can be exposed either by dissecting the orbit from above downwards, or from below and from before by removing the lower eyelid, and dividing the inferior palpebral sinus of the conjunctiva: it receives on its ocular surface the long branch from the inferior division of the third nerve, which is connected to the lenticular or ophthalmic ganglion. *Use.*—The two oblique muscles may be considered as running from the inner side of the orbit to the outer and back part of the eye, nearly at right angles with its antero-posterior axis, one above, the other below it, and are peculiarly well adapted for rotating the eye on this axis, that is, on a line supposed to pass through the centre of the cornea and of the eyeball backwards towards the apex of the orbit. The lower oblique will roll or rotate the upper and outer part of the cornea round this line downwards and inwards, and the superior oblique will roll it in the opposite direction, and rotate the upper and inner border downwards and outwards. They cannot have much influence in rotating it either on its transverse or vertical axis unless assisted or wholly unopposed by the recti; neither can they execute the circumductory motions. Mr. John Hunter, in an essay (Animal Economy, p. 254) on the action of these muscles, has fully stated the difference between their action and that of the recti, and has clearly explained their power and their use as rotators of the eyeball round the antero-posterior diameter. A simple and satisfactory experiment, also, has been made, and detailed by Dr. G. Johnstone, (*see* Todd's Encyc. of Anat., art "Orbit,") where each of these muscles being exposed and excited to contraction by the electric current, these rotatory motions were instantly and rapidly performed. These muscles, also, from their oblique course backwards, one a little downwards, and the other upwards, can also turn or rotate the eye somewhat on the other axes, so as to alter the direction of the antero-posterior one, and thereby the aspect of the cornea and pupil. It is difficult to determine the extent and even the direction of this power during life and

health, as one or more of the recti may be, and generally are, engaged at the same time; neither can it be very decidedly proved in the dead body, for traction of the muscle is but an unsatisfactory test, where the organ, having lost the steadying or balancing influence of the recti muscles, is only supported by soft and yielding structures. Traction of the inferior muscle appears to direct the cornea somewhat upwards and inwards; and that of the superior oblique is said by many to direct it downwards and outwards, while others mantain that it directs it downwards and inwards; but the general opinion, and, I believe, the correct one, is, that it turns it downwards and outwards.* From the slanting direction of these muscles backwards they have been considered by some not only as antagonists to the retracting influence of the recti, but that they can also draw forward the eyeball, as in staring intently on any object; the prominence of the eyeball, however, at this time, is probably apparent rather than real, and some deception may arise from the greater elevation of the upper lid, and consequent exposure of a larger portion of the sphere; the eye, however, is always a little protruded by the elevation of the superior palpebra. Those who maintain that the recti can, by their combined action, alter the form of the eye, also attribute to the oblique an influence of the same nature, either assisting, modifying, or perhaps antagonizing that of the recti, and conceive that, by these agencies, the interior of the optical apparatus may be adjusted to vision of objects at different distances. This hypothesis, however, does not rest on any positive proof, and indeed, from the nature of the inquiry, appears almost incapable of it. The oblique muscles may also be considered as supporting the eye on its outer or temporal side, where the wall of the orbit is short, forming a sort of sling around the outer side of the globe, and may thus not only oppose the abducting power of the external rectus, but also suspend the organ, and incline it towards the inner rather than to the temporal side of the cavity, and thus both oblique muscles can co-operate with the internal recti. In rotation of the cornea downwards and outwards the superior oblique may be assisted by the inferior and external recti, while their combined power will be resisted, or rather balanced, by the superior and internal recti and by the inferior oblique; in rotation of the cornea upwards and inwards the inferior oblique may be assisted by the superior and internal recti, and balanced or opposed by the superior oblique and inferior and external recti. Excessive action of the superior or of the inferior rectus may be resisted, the former by the superior oblique, the latter by the inferior. Although both oblique are said to draw the eye forwards, this does not appear so evident in traction of them in the dead state, because the eye is thereby drawn inwards; perhaps, however, during life, this latter tendency being opposed by the external rectus, they may exercise that influence in a slight degree.

It is difficult, even by the closest observation on the living, to appreciate the precise action of the orbital muscles, either individually or combined, for almost all the motions of the eyeball are beautifully and wonderfully assisted by the lateral and antero-posterior motions of the head upon the atlas, and by the rotation of both upon the dentatus, as well as by the mobility of the cervical vertebræ generally. In the exercise of vision, although the cornea and pupil appear to have changed their direction, and really have done so in one sense, yet the change may have been effected at the occipito-vertebral articulations, and the orbital muscles have been engaged, not so much in moving or rotating the organ, as in keeping it fixed and steady, and thereby retaining its antero-posterior diameter in the visual axis. Another circumstance which deserves attention, when analyzing the actions of the orbital muscles, and one extremely interesting in itself, is the consent or association between certain

* In the former editions of this work I have stated, I believe incorrectly, "downwards and inwards."

muscles, and the antagonism between others; and these principles may be observed in operation not merely in the muscles of one side, but of both. Some circumstances in the nervous arrangements in this region, already alluded to (*see* Nervous System), may partly explain these phenomena. Thus the third nerve supplies five muscles of this group, viz., three recti, one oblique, and the levator palpebræ, and it also, most probably, endows the iris with its motor power. This nerve, therefore, associates these parts in a remarkable manner; thus the levator palpebræ and levator oculi act in unison, and the inferior oblique and internal and superior recti concur in turning the cornea upwards and inwards, as in sleep, and the iris is at the same time contracted. There is also an association between those muscles in each orbit which are supplied by these nerves; thus both eyes always move together upwards and downwards, and volition cannot alter this tendency. The internal recti can also act in unison, and adduct both eyes; this motion, however, is rather a constrained one. The sixth nerves also exhibit a consentaneous action in returning the eyes from this state of forcible adduction to their former state; yet the external recti do not concur in their ordinary action of abduction, as when one eye is turned outwards the opposite is directed inwards; they cannot maintain the eyes in a state of divergence, and hence, probably, this nerve is destined to this single muscle. The superior oblique muscle, in like manner, receives but a single nerve, and is not associated with that of the opposite side; when the pupil of one eye is directed downwards and outwards, that of the other looks downwards and inwards. There are, therefore, certain combinations of muscular actions that cannot be explained on the anatomical nervous arrangements, or on any settled principles of consent or of antagonism. Thus, when one eye is everted, the internal rectus of the opposite side is in action, and, therefore, the two internal recti are then opposed, or, in other words, there is an association between the sixth and third nerves of opposite sides, nerves which, in most other motions, are in opposition. When the superior oblique and external rectus of one eye direct it downwards and outwards, the opposite eye is directed downwards and inwards by the inferior and internal recti; we then have an association and consent between nerves and muscles which, at other times, are totally opposed. To these and many other examples, which do not come within the scope of the explanation above mentioned, we might add that the motions of the head upon the spine are as rapid, and as consentaneous with every required change in the direction of the cornea, as are those of the orbital muscles; and certainly no anatomical nervous arrangements that we know of can satisfactorily account for that connection. Though pleasing to the speculative anatomist to attribute the several combinations of the actions of the orbital muscles to the peculiar distribution of the nerves, each aided "either by the impulse of consentaneous motion or of antagonism," yet we must confess that the theory is inadequate to explain all the phenomena, although it suits several of them. Many of these combined and opposing actions, and which are in a great degree involuntary, appear to be innate or instinctive tendencies in certain muscles to act under certain circumstances; or they have gradually and imperceptibly acquired the power by practice and habit, so that the mind is unconscious of their acts; or, according to the excito-motor theory, the impressions made from without are rapidly conveyed to the nervous centre, and as rapidly give rise to the reflex motion in the manner required. The actions of the orbital muscles, and the association of the latter by different nerves, are of great interest, not only in connection with anatomy and physiology, but especially with the pathology of the eye and its appendages. Our limits, however, will not permit us to pursue the inquiry further. Should the student wish to do so, he may consult with advantage Hunter's An. Econ. (*loc. cit.*); Muller's Phys. by Baly (p. 100, *et seq.*); Sir C. Bell on the Nervous

System (p. 170); also a paper by Dr. Evers on the Physiology of the Muscles and Nerves of the Orbit (Dublin Journal of Medical science, May, 1841, p. 165). Sir C. Bell concurs in the general opinion that the superior oblique muscle turns the pupil downwards and outwards, and the inferior oblique turns it upwards and inwards under the upper eyelid. He further considers that both perform the involuntary movements of the eyeball, and produce an insensible rolling of it, holding it in a state of suspension between them. He also considers that the eye is always rolled by the inferior oblique upwards and inwards, under the protection of the upper lid, in sleep, or during any violent excitement, as in difficult respiration and sneezing. To support this opinion he has recourse to the strange hypothesis that the fourth nerve causes a relaxation of the superior oblique, and, therefore, the inferior must roll the eye in this direction with greater effect. There is no good reason, however, to support this novel theory, "that an active influence of a nerve can cause a relaxation of the muscle it supplies;" neither is there any ground for assuming that the inferior oblique muscle is less a voluntary one than the three recti and the levator palpebræ muscles, which are all supplied from the same, or the third nerve.

The bloodvessels which supply the parts within the orbit are the ophthalmic artery and its ramifications, assisted by small vessels from the facial, temparal, and internal maxillary arteries. The *ophthalmic* arises from the internal carotid just as the latter has emerged from the cavernous sinus, and is curving upwards by the side of the anterior clinoid process; it immediately becomes attached to the sheath of the optic nerve, being placed inferior and rather external to it, passes through the optic foramen into the orbit, and still bears the same relation to the nerve; it soon, however, ascends obliquely over it, and passes forwards and inwards to the nasal side of the orbit, and finally terminates at the inner canthus. This vessel sends off numerous branches to supply the optic apparatus. These have been already noticed (*see* Vascular System); they mostly accompany the branches of the ophthalmic division of the fifth nerve. The veins which return the blood from the eye and its appendages to the general system do not exactly correspond to the ophthalmic artery and its branches. The veins of the temple, forehead, and face, receive the branches from the eyelids, also some from the inner side of the orbit; others pass through the spheno-maxillary fissure, and join the deep temporal veins: those from the ocular portion of the conjunctiva, from the lachrymal gland, the muscles, and fat of the orbit, also the ciliary, choroid, and retinal, all proceed backwards, end in three or four branches, which unite into one considerable vein, the *ophthalmic*, which escapes from the orbit by the inner wide portion of the sphenoidal fissure, generally below the lower origin of the external rectus muscle, but sometimes between its heads, also inferior to the sixth nerve; it then enters the cavernous, whence the blood is carried by the petrous sinuses to the internal jugular veins; sometimes there are two ophthalmic veins. one between the heads of the recti, the other beneath them.

The nerves which supply the optic apparatus have been already examined (Nervous System, page 437), and, with the exception of the optic, have been individually described. Considering the size of the eye and its appendages, these nerves are large and numerous, and present some interesting peculatities. No less than four entire nerves, and a portion of three others, are distributed to this organ, namely, the second, third, fourth, and sixth; one division of the fifth, and branches of the seventh or facial and of the sympathetic. Each of the cerebral nerves arises from a distinct part of the nervous centre, and each ministers to some distinct and special purpose, which can be ascertained in respect to many of them with tolerable certainty, but, in respect to others, is still involved in obscurity and doubt. Their respective functions have been deduced partly from observation, experiment, and reasoning from analogy,

and partly from pathological research. The optic nerves are remarkable and peculiar for the intimate connection that exists between them. The original, or central attachment, may be considered as one common point of union, for the corpora geniculata and quadrigemina, the optic thalami, the posterior, and the pineal commissures, all constitute one central nervous mass, through which the nerves of opposite sides are united into one: each tractus, in its course forwards, is in close apposition with the crus cerebri, the great volition tract, and anteriorly it is connected to the tuber cinereum and to the thin extremity of the corpus callosum, or superior cerebral commissure. In front of the pituitary body the two nerves are joined in the chiasma, or commissure, partly by transverse and partly by decussating fibres; thence each passes forwards and outwards, of a flattened form, invested by a close neurilemma of pia mater and a loose sheath of arachnoid; the latter is reflected from it in a *cul de sac* in the foramen opticum of the sphenoid bone. Here the nerve receives a sheath from the dura mater, one layer of which joins the orbital periosteum, the other incloses the nerve as far as the sclerotic, with which fibrous membrane it becomes continuous. Having passed through the foramen, the nerve is encircled by the annular tendinous origin of six of the orbital muscles, and then bends somewhat, and proceeds forwards, and a little inwards and downwards, to reach the back part of the eye, which it joins on the inner side of its antero posterior axis, and is here obviously constricted; it then passes through the sclerotic and choroid tunics of the eye, as will be seen in the dissection of the globe. From the optic foramen to the eye its course is tortuous, and longer than the space it traverses, whereby it admits of the free motion of the ball without itself sustaining any tension or extension. It is surrounded by the recti muscles, some adipose substance, and anteriorly by the ocular fascia. The ophthalmic ganglion lies upon its outer side, and the ciliary nerves and vessels twine around it. In the optic foramen the ophthalmic artery is beneath it, but, in the orbit, this vessel bends around its outer and upper aspects to its inner side; near the globe its ramus centralis retinæ pierces the nerve obliquely, and runs along its axis to the interior of the eye. Of the functions of the *optic nerves* there can be no doubt: their expanded terminations receive the impressions of the rays of light which impinge upon their concave surface, and the nerves transmit these impressions to the brain, the seat of perception. The office of the palpebral filaments of the *facial* is also well established: they endow the orbicular or sphincter muscle with motor power, whereby it closes the lids and protects the eye from injury, and shades it from the light. When this nerve is suffering from paralysis, a common result of inflammation of its sheath in some part of its course, the eye remains constantly exposed, and the individual cannot close it, neither are the tears directed to the puncta; the features on the same side are also affected, and the expression of the countenance is changed. During sleep, however, the eye is partially covered, as the upper lid falls from the relaxation of its levator muscle. The other five nerves are all closely grouped together by the side of the body of the sphenoid bone, in the wall of the cavernous sinus, and from what I have ventured to name the *orbital plexus;* an arrangement somewhat analogous to the great plexuses on the spinal nerves, only that in this the nerves do not decussate or interchange their filaments, but pursue their course unbroken. In this plexus, however, more or less connection exists between the several nerves, and a sort of general union is effected by the filaments of the sympathetic; and, as the plexus at the head of each upper and lower extremity associates the several nerves which are to supply the region beneath, so this may be designed to effect a similar purpose with regard to the orbit and its contents. All the nerves of this plexus enter the orbit through the foramen lacerum or sphenoidal fissure, and soon separate, each passing to its destination. The *third* resembles nerves in the other

parts of the body, by dividing into several branches to supply different muscles, no less than five, namely, the levator palpebræ, the superior, internal, and inferior recti, and the inferior oblique; it is also connected to the lenticular or ophthalmic ganglion by a short, thick filament, which passes between this body and the long branch to the inferior oblique muscle. This nerve is named the *motor nerve* of the orbit, as it seems to excite so many of its muscles, and most probably the iris. This pair arise very close together from the base of the cerebrum, and serve not only to excite, but also to associate several muscles in each orbit, as well as those of opposite sides, and produce their consentaneous action. Thus the levator palpebræ and oculi act together on one or on both sides, and also the levator and depressor of both eyes; and in sleep the internal and superior recti and inferior oblique act together, and the iris also is contracted. That the lenticular ganglion should be connected in all cases to the inferior oblique nerve cannot be perfectly explained; though it may be suggested that, as both oblique muscles are important agents in the optic apparatus, in adjusting the axis of the eye to the visual line, by the delicate rotation and balancing of the globe, so a special connection is established between this muscle and the iris by the same motor nerve, whereby the contraction and expansion of the pupil become consentaneous with certain motions of the eyeball, as well as from the influence of increased or diminished light. Paralysis of the third nerve affords negative evidence, which assists in proving its function to be motor: several of the motions of the eye are lost, the upper lid droops, and cannot be raised by volition (ptosis); the ball appears fixed, the cornea cannot be directed upwards or inwards, but may be everted by the external rectus, and rotated downwards and outwards by the superior oblique; the iris is often dilated and insensible to light, or responds feebly to its influence; vision is feeble, imperfect, and often double, as the affected eye cannot follow the motions of the sound one, so as to preserve the parallelism of their axes, and, therefore, the pencils of luminous rays from the object do not fall upon the corresponding parts of the two retinæ. In this affection, when vision becomes much impaired, we may suspect that either the optic nerve, or some part of the brain itself, has also become diseased. The *fourth*, or trochleator nerve, forms a striking contrast to the third, being exclusively distributed to the superior oblique muscle; it is remarkable for its remote and peculiar origin, delicate size, and long and isolated course to the orbital plexus; it is the motor nerve to the trochleator muscle, but most probably it also carreis with it some sensitive filaments from the plexus in the sinus, or from the ophthalmic nerve when crossing it in the foramen lacerum. Although the fourth pair arise very close together, the muscles they supply are not associated in their actions. From the proximity of their origin to that of the optic nerves they appear well adapted for exciting reflex motion in accordance with any peculiar impression made upon the retina; and these muscles, like the inferior oblique, which are associated with the iris, are, most probably, of great service in effecting the delicate or adjusting motions of the visual axis. Paralysis of the fourth nerve and trochleator muscle so seldom occurs, as a separate and well-marked affection, that no conclusion can be deduced from it as to the function of either. The *fifth* nerve, or the ophthalmic, accompanies in a great measure, the ophthalmic artery, and supplies filaments to all the appendages of the eye, to its mucous surface and lachrymal apparatus, also to the ophthalmic ganglion and to the internal structure of the globe. It is a sensitive nerve, and imparts feeling and organic sensibility to the eyelids, conjunctiva, and to all parts within the orbit; its minute filaments accompany the nutrient and secreting vessels, and serve to maintain the healthy organization of the entire apparatus, and thus indirectly to assist the optic nerve in its special function. How far the orbital branches of the symphathetic may aid the ophthalmic nerve in nutrition and secretion is unknown, but most probably they exert

some influence in these respects. When the fifth nerve is paralyzed, the eyelids and conjunctiva, and even the cornea become insensible to contact; the surface is dry, or not moistened as usual; the lachrymal secretion is suspended; the iris is sometimes sluggish and languid; the healthy state of the tissues is deranged, and the cornea becomes the seat of destructive inflammation, and vision is impaired and ultimately lost; the optic nerve itself, also, not unfrequently falls into an unsound state, during the course of the disease. The *sixth*, or *abducens* nerve, resembles the fourth in being distributed exclusively to one muscle, the external rectus, paralysis of which is denoted by the internal strabismus, the inability to direct the cornea or iris towards the temple, and by the imperfect and double vision when the individual attempts to look outwards towards the affected side. This nerve communicates more freely or directly with the sympathetic than do the other orbital nerves. The precise office of the *sympathetic nerves* in the orbit is not ascertained. These filaments arise from the superior cervical ganglion, accompany the internal carotid artery, and in the cavernous sinus join, first, the sixth nerve, and subsequently the other nerves in the plexus; branches accompany the ophthalmic artery and its ramifications, and a delicate twig joins the nasal root of the lenticular ganglion. As branches of the sympathetic accompany the nutrient arteries in other parts of the body for the purposes of organization, we may suppose they assist in this office in this region; they also maintain a connection between the several nerves of the orbit, and between the ophthalmic and the other ganglions in the system; but the exact object of the latter we cannot determine, although it may seem to explain the sympathy between the eye and the viscera of organic life. Thus the excited or depressed action of the heart quickly changes its appearance and expression, and many diseases of the digestive system are not unfrequently attended by, and probably in some instances the exciting cause of, deranged action of the orbital nerves and muscles, and of impaired vision; and these latter affections sometimes disappear as the former have been removed. In addition to these several nerves, the superior maxillary also sends some sentient filaments into the orbit, through the spheno-maxillary fissure; these supply the cellular and adipose tissue, and one (the malar) not unfrequently communicates with the lachrymal branch of the ophthalmic.

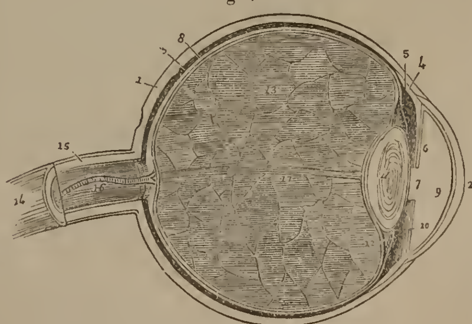
SECTION V.

DISSECTION OF THE GLOBE OF THE EYE.

The eye is placed at the anterior and internal part of the orbit, behind the conjunctiva, surrounded by fascia, muscles, vessels, nerves, and adipose substance, and retained in its situation by the optic nerve, the recti and superior oblique muscles, which support or suspend it in the surrounding fat, and admit of its free and easy motions. It is small in comparison with the cavity which contains it. In some persons it appears more prominent than in others; the variety in this respect depends partly on the amount of adeps in the orbit, and partly on the size of the palpebral opening; it is also absolutely larger in some than in others. The eye is nearly spherical, and about one inch in diameter; but, in consequence of the slight projection of the cornea, which is a segment of a smaller sphere superadded to the larger one formed by the sclerotic, the antero-posterior axis is one or two lines longer than the transverse. A transverse section dividing it into an upper and lower half, or a vertical section dividing it into a right and left portion, will exhibit an oval outline; but a perpendicular section, cutting it into an anterior and posterior half, will exhibit the circular form. The long axes of the eye are nearly

parallel to each other, and, therefore, not so to that of each orbit. The eye is a hollow globe, the wall or shell of which is composed of different membranes or tunics, and the cavity is filled by transparent fluids or humors for optical purposes. The *coats* are three, the sclerotic, the choroid, and the retina; these fit accurately one within the other, and are in close apposition. The first is called sclerotic; it is a fibrous membrane for the protection and maintenance of the form of the organ; it invests the posterior four-fifths, and presents a circular opening in front, into which the transparent cornea is inserted, which completes the anterior fifth; the cornea and forepart of the sclerotic are also covered by the conjunctiva. Within the sclerotic is the second tunic, the choroid, extremely vascular, and containing the nutrient vessels and nerves; it also secretes the brown or black pigment, which deeply stains the interior of the globe and the back of the iris, to prevent the reflection of the rays of light from the bottom and sides of the organ back again through the retina. In the anterior part of this tunic there is also a circular opening or deficiency, into which the iris is fitted, as the cornea is into the sclerotic. External to the circumference of the iris the choroid is intimately attached to the sclerotic by the ciliary band or ligament; and internally and behind the iris it is connected to the membrane of the vitreous humor by a series of folds, called ciliary processes, arranged in a circular form around the margin of the crystalline lens. The third or innermost tunic is the retina, the delicate expansion of the optic nerve; this extends from the entrance of the nerve, at the back of the eye, all around the interior of the choroid membrane, and terminates in front about two lines behind the anterior border of the latter; this is the essential part of the organ, being endowed with sensibility to light; all the other parts may be considered as subordinate to it. The *humors* of the eye are the aqueous, the crystalline lens, and the vitreous; these, though of different densities, and inclosed in membraneous capsules, are all transparent, and exactly fill the globe. The aqueous fluid occupies the space between the cornea and the lens; the iris floats and moves in this fluid, and divides the space into two chambers, the anterior and posterior. The anterior is between the cornea and iris, and the posterior between the iris and the lens and vitreous humor; this space is very small, and both communicate freely through the pupil, or the circular aperture in the centre of the iris. All the posterior region of the eye is filled by the vitreous humor, a soft, gelatinous, transparent mass, composed of the most delicate cellular membrane, the cells filled with fluid. In a depression on the forepart of this substance, and behind the pupil and iris, is placed the crystalline fluid or humor, of greater density than either of the other two, and of the form of a double convex lens. Each of the parts thus alluded to in a general way, may next be examined individually and minutely. The eye should be carefully removed from the orbit, and its surface cleanly dissected; the optic nerve and the tendinous insertions of the muscles may be retained.

Fig. 73.*



The *tunica sclerotica* (*σκληρος, durus*). This, together with the cornea in front, forms the external

* A longitudinal section of the globe of the eye. 1. The sclerotic or fibrous tunic

coat or case of the eye, and extends from the optic nerve to the circumference of the cornea: it is a dense, opaque, fibrous membrane, very strong and inelastic, preserving the figure of the organ, and protecting from injury and pressure the delicate structures within; it has been named by some "cornea opaca," κερατοειδης, κερας, *cornu*, ειδος, *similis*, but incorrectly, as it has no analogy in structure to the true cornea. It is covered posteriorly by cellular tissue, by the ocular fascia, and by the recti muscles; more anteriorly by the tendons of the obliqui and recti and by the conjunctiva, which externally is rather loosely connected to it by a fine cellular tissue prone to serous infiltration, but near the cornea is more intimately attached to it. The expansion of the recti tendons covered by the conjunctiva has been considered by some as a partial tunic to this region of the eye, and has been named "albuginea," or "adnata;" and to its peculiar tissue has been ascribed the white and glistening oppearance of this portion of the organ, commonly called the "white of the eye." No such distinct tunic, however, exists; neither do the margins of the tendons unite, and the interstices present the same clearness and brightness of color. The sclerotic membrane, if recent and cleanly dissected, is of a glistening, white, fibrous texture. Near the entrance of the optic nerve it is pierced by numerous small foramina for the short ciliary nerves and vessels; more anteriorly by small oblique canals for the long ciliary; and a little behind the transverse axis there are four or six larger canals for the exit of veins; towards its anterior surface small depressions exist corresponding to the insertions of the recti tendons. Make a circular division of this membrane, reflect one portion forwards towards the cornea, the other backwards towards the optic nerve; each portion may be again divided from before backwards; the inner surface and the density of this tissue may be then observed. The internal surface of the sclerotic is in contact with the choroid membrane, and is stained by the brown pigment, particularly towards the back part; and as this is found in the very recent eye it is most probably the permanent state, and not the effect of *post mortem* transudation. This surface is smooth, and connected to the choroid by the ciliary nerves and vessels and by fine filamentous tissue. These attachments are easily broken by the thin handle of the knife, or eye-end of the probe, and thus the sclerotic can be turned or peeled off the choroid without injury to the latter. When this inner surface is washed clean it presents a smooth and glossy appearance, and a very fine, serous-like lamina may be dissected from it. This lamina has been described by some as a true serous membrane, lining the sclerotic, and reflected from it anteriorly and posteriorly upon the choroid, forming a close serous cavity between the two. To produce this appearance, which is probably more artificial than natural, the ciliary vessels and nerves, and the cellular connection between the two membranes, must be ruptured. This surface presents the several openings seen externally, also fine grooves in which the vessels and nerves run for some distance before they cross over to the choroid membrane. The divided edges of the sclerotic exhibit its density, which is greatest posteriorly near the optic nerve; thence it becomes gradually thinner towards the centre; in front of the transverse diameter, however, it receives the addition of the recti tendons; but the whole of the anterior portion is so thin that, in the child and in delicate young persons, the black color

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2. The cornea. 3. The choroid or vascular tunic. 4. The ciliary ligament, containing the supposed canal of Fontana. 5. The ciliary processes. 6. The iris. 7. The pupil. 8. The retina or nervous coat. 9. The anterior chamber of the eye, containing the aqueous humor. 10. The posterior chamber. 11. The crystalline lens, inclosed in a fine capsule. 12. The canal of Petit. 13. The vitreous humor inclosed in the cells of the hyaloid membrane. 14. The optic nerve. 15. Its sheath or neurilemma. 16. The arteria centralis retinæ, a branch of the ophthalmic artery. 17. A branch of the central artery of the retina passing through the vitreous humor to the capsule of the lens.

of the choroid appears through it, and gives to this part of the eye a peculiar dark or deep bluish tint. The superior thickness of the sclerotic posteriorly is more remarkable in many other animals, and more so in proportion as the eye deviates from the spherical form. In the ruminants, as ox and sheep, it is well seen, also in the horse, but little so in the elephant, as in it the eye is nearly globular; and it is most striking in the cetacea. The optic nerve perforates the sclerotic about a line and a half internal to the antero-posterior axis. As the nerve approaches this point it is suddenly constricted; its fibrous sheath of dura mater is intimately united to the sclerotic, and the contracted nerve passes through a small aperture in the membrane, which appears traversed by fibres, and has received the name of "lamina cribrosa," through the foramina of which the filaments of the nerve are supposed by some to pass in separate fasciculi, as those of the olfactory and auditory nerves pass through the osseous cribriform plates. This mode of passage through the sclerotic, however, is by no means distinct, and this cribriform appearance may partly depend on the structure of the nerve itself and the vessels which accompany it. When the nerve is squeezed, the fibrous substance, no doubt, exudes on the concave surface in minute and distinct points, in the centre of which one appears much larger than the others, and is of a red or dark color; this is named "porus opticus," and transmits the central artery of the retina. In like manner, if the nerve be divided behind this in any part of its course, and then squeezed, the medullary substance will exude in the same manner. If the nerve be shaved off from both surfaces parallel to the plane of the opening in the membrane, and the latter macerated for a little time, a thin membraneous tissue will be found to occupy the opening, and to be continuous with or connected to the margin, which is thin and not very accurately defined. Immediately around the opening the increased density of the sclerotic commences. In the anterior part of the sclerotic is the large opening, into which the transparent cornea is inserted, of nearly a circular form; the transverse axis is said to exceed the vertical from half a line to a line; the margins of the sclerotic are bevelled off obliquely, the outer lamina extending farther than the inner; and between the edges there is a shallow groove or depression. Into this opening the cornea is fixed by several means of attachment, which dissection or maceration cannot open; rapid boiling assists but imperfectly. These two tissues, so completely opposed in physical properties and in structure, are yet most intimately united: first, as the conjunctiva extends from the sclerotic in front of the cornea it adheres almost inseparably to their border of conjunction, and assists in the latter; second, the outer layer of the sclerotic overlaps the cornea by so fine and thin an edge as not to cause the least projection; this overlaying is more considerable above and below than laterally, and hence the transverse diameter of the cornea appears to exceed the vertical; third, the inner or elastic lamina of the cornea, on the other hand, is prolonged behind the sclerotic, between it and the ciliary ligament; fourth, the circumference of the proper laminated cornea is adherent to the groove in the sclerotic by strong fibrous tissue; the short, white fibres of the sclerotic appear ingrained like the teeth of a suture into the plates of the cornea; and, lastly, the lining membrane of the cornea, which is continued to the ciliary ligament and iris, assists in the union of these parts. This apparently simple but truly complex structure is best seen by carrying a section through the cornea and forepart of the sclerotic, and then opening the line of union partly by dissection and partly by forcibly tearing the parts asunder. The sclerotic membrane is a true fibrous structure, and one of the strongest in the body; its fibres interlace in every direction, and no true division into laminæ can be effected by dissection or maceration; though perforated by vessels and nerves, it possesses but little organization or sensibility in the normal state; it receives some very small

filaments from the ciliary nerves, and its arteries are derived posteriorly from the ciliary, and more anteriorly from the muscular branches of the ophthalmic; small branches from the latter also pass forwards, pierce the recti tendons, and converge towards the cornea, where they are too minute to follow or to inject; but in inflammation of the iris they become enlarged and distinct, and form the peculiar vascular pink zone, behind the junction of the cornea and sclerotic, so characteristic of that disease. The sclerotic, though insensible in its healthy state, yet when attacked with rheumatic inflammation, common to fibrous tissues, becomes the seat of intense pain; and when the globe is distended from suppuration or effusion, its dense and unyielding tissue considerably aggravates the sufferings of the patient.

Cornea (like horn) forms the anterior fifth of the globe, and completes the external case; it projects beyond the level of the sclerotic, being a small segment of a smaller sphere ingrafted on the larger one formed by that membrane, and though intimately united to it, is totally different in structure and organization; it is a perfectly transparent layer of animal tissue, convex and highly polished anteriorly, concave and smooth posteriorly; its form is circular, but very accurate measurement shows that its transverse diameter exceeds the vertical by nearly one line; and Haller asserts that its nasal side is circular, while its temporal is elliptical; its posterior surface is more accurately circular and more extended than its anterior, in consequence of the sclerotic overlapping the latter above and below more than on either side; it is rather thicker than the sclerotic, particularly in the child, and its circumference, being bevelled off externally and overlapped by the sclerotic, as was already described, is thinner than its central portion. Transverse or vertical sections of it from the eyes of the larger mammalia clearly exhibit a greater thickness in the centre; but in fish it is the contrary. In the human eye the difference is not very considerable, but sufficient to show that the two surfaces or curvatures are not precisely parallel; consequently, the cornea cannot be considered a simple meniscus, that is a concavo-convex medium, with its two surfaces parallel, and, therefore, with its curves of equal diameter; but, being thicker in the centre, it is also a lens with refracting and converging powers. A simple meniscus would merely transmit all rays of light falling parallel to its axis, as a transparent crystal; but experiment proves that the cornea has a magnifying power, and, as Haller has correctly stated, if removed from a recent eye, and held over the letters in a book, it magnifies them. Its refracting and converging powers may be further deduced from the fact that the optical powers of the eye are partly retained after the successful extraction or removal of the opaque crystalline lens, especially in young persons. The cornea, though perfectly diaphanous, is of a complex structure, and consists of different tissues:—First, it possesses a fine *epithelial lamina*, derived from the conjunctiva of the surrounding sclerotic. This has been already alluded to; it is exquisitely sensible, is composed of cells, the superficial orders are flat and smooth, the deeper are rounder and smaller; they contain a clear fluid, and, very soon after death, become white and opaque, and form the peculiar film upon the eye; when this has been wiped off the subjacent cornea is found clear. This change sometimes commences even before death, and the eye loses its lustre. Second, the peculiar or *proper cornea* consists of transparent lamina, soft and flexible; their number is undetermined, depending in a great measure on the degree of maceration and the patience of the dissector. These are connected together by a fine, transparent, areolar tissue, which contains a small quantity of fluid, and maintains the laminæ in their proper relations to each other. A slight alteration in this respect will impair the transparency of the whole; thus, if the perfectly fresh eye of the sheep, suppose, be gently squeezed in the hand, the cornea becomes gradually milky, and as the pressure is removed,

the clearness returns. Maceration causes infiltration into this tissue, and thus renders the cornea opaque; but, if the lamellæ be then separated, they will still be found transparent: if boiled, however, or long suspended in spirit, they become permanently opaque. In the eye long dead, the cornea becomes flaccid, and loses a portion of its convexity, and the lamellæ glide on each other when pressed by the finger; this is probably owing partly to the transudation of the aqueous humor, as well as to changes in the areolar tissue between the laminæ; and, no doubt, on the healthy condition of the latter much of the plumpness and clearness of the cornea depend. Dulness of vision, caused by distension of the eye, or by pressure or injury, may partly depend on derangement of this tissue and altered relations between the corneal laminæ; it is this portion of the cornea that is so inseparably united to the sclerotic. When sections of the cornea are examined under the microscope, fine fibres are seen uniting the lamellæ, and the latter appear very thin and numerous, and present minute cells. Although at first view these plates bear some resemblance to chondrine or cartilage, they are most probably composed of a peculiar modification of fibro-cellular tissue. Third, posterior to the proper laminated cornea is a thin, but strong, elastic, cartilaginous lamina, named the *membrane of Demours;* it is perfectly transparent, and in close apposition with the cornea, between it and the membrane of the aqueous humor. It appears homogeneous and hyaline. The eye of the horse, and also that of the elephant, present it in great perfection.* Its transparency is not affected by those agents which render the cornea opaque, and is retained for an interminable period when suspended in spirits. This lamina extends beyond the proper cornea, and fits in by a defined margin between the sclerotic and the ciliary ligament, as has been correctly noticed by Jacob, (Med. Chir. Trans., vol. xii. p. 504.) By this writer this lamina is named the elastic cornea; it bears a close analogy to the capsule of the crystalline lens, but is thicker and stronger; it serves to support the cornea, and to preserve its proper curvature. This lamina is easily exposed in an eye macerated for a few days; the cornea proper, which has become opaque, can be raised off, and the transparent elastic cornea left uninjured; it appears devoid of all vessels, although in iritis it becomes opaque; it must, however, be difficult to determine how far this appearance depends on an alteration in this tissue, or on the next that enters into the composition of the cornea, viz.:—Fourth, the membrane or *capsule of the aqueous humor,* a tissue of such exquisite delicacy that its demonstration on the back part of the cornea is extremely difficult, and its existence has long been inferred rather from analogy than from ocular proof. We shall allude to it again when examining the humors of the eye. The cornea, in its normal state, never admits red vessels, neither can nerves be satisfactorily traced into it; its surface, but not its substance, is exquisitely sensible; in disease, however, not only does the surface become vascular, but also its proper tissue; deposition of lymph occurs between its laminæ, causing various degrees of opacity. The process of ulceration in all its stages may be occasionally observed in it, and wounds heal by the first intention in a very short time. These facts indicate a high degree of organization. The cornea forms a strong and transparent window in the front of the eye, less liable to rupture or to yield under distension than the sclerotic; it also serves to transmit, and at the same time to refract or bend towards a focus, the rays of light. Being bright and highly polished, like a convex mirror, it also reflects a portion of the light which falls upon it, thus contributing to the brilliancy and expression of the eye; this reflected light also forms the images which we see behind the cornea in the eye of another.

* See Preparations in Museum.

Choroid coat is the second tunic in the eyeball, and is so named from an imaginary resemblance to that vascular organ in the gravid uterus called chorion: it is a soft membrane, of a dark brown color, extending from the optic nerve as far forwards as the ciliary ligament, which is internal to the line of junction between the cornea and sclerotic, and external to the iris. This ligament and the ciliary processes may be considered as appendages to it; it is pierced posteriorly by an annular foramen for the passage of the optic nerve, which has but little connection to its border; anteriorly it presents a large opening, into which the iris is inserted, analogous to the circular deficiency in the sclerotic into which the cornea was received; it forms a sort of case between the sclerotic and retina, connected to the former by cellular tissue, vessels, and nerves, but merely lying in apposition with, and not adhering to, the smooth surface of the latter; it is extremely vascular and organized, and serves as the medium not only for connecting different parts of the organ, but also for conducting vessels and nerves to the interior, especially to the iris; and it also secretes the dark pigment so essential to the optical purposes of the eye. When successfully injected with a colored fluid, it appears to equal in vascularity any of the mucous membranes, or the papillary surface of the cutis, which tissue it also resembles in presenting on its convex or adherent aspect a coarser or cellular texture, containing larger vessels, particularly veins and nerves. Internal to this is a most vascular lamina, composed of a beautiful network of capillaries, and on the inner concave surface of the latter a pigmentary secretion. The anatomist can actually divide it partially into these three lamina, and hence the choroid coat has been described by some as composed of three membranes, an external or venous, a middle or arterial, also called Ruyschiana (from Ruysch, who, by his beautiful injections, attracted great attention to it), and an internal or pigmentary. Such divisions, however, are useless, and merely artificial; it is but one membrane, highly organized and vascular, externally rough and cellular for connection to the sclerotic, and containing the larger vessels and nerves; as these enter into the tissue they subdivide minutely before they reach the inner or more vascular and villous surface. The veins on the outer surface are remarkable for their size and peculiar arrangement, and have been named "vasa vorticosa." Four or six considerable veins may be observed about the middle of this surface; numerous small vessels run in clusters towards each of these, at first from behind forwards, then bend round in gentle curves, compared to the branches of the weeping willow; these are joined by small vessels from the forepart, and unite in the larger trunks; these then pass from the choroid into the external cellular tissue, pierce the sclerotic obliquely, and make their way to the ophthalmic vein. In a recent eye these veins are sometimes beautifully distinct, being injected with blood, which becomes reddened by exposure to the air. On the surface of the choroid the ciliary nerves and arteries are also seen; of the latter a great number penetrate into its tissue, a little distance from the optic nerve; the long ciliary arteries pass on undivided, in company with the ciliary nerves, as far as the ciliary ligament, through which they pass in their course to the iris; to the latter organ the nerves are chiefly destined, but most probably small filaments also accompany the arteries of the choroid membrane. This external lamina of the choroid is very intimately connected to the ciliary ligament; the sclerotic coat can be easily detached from the choroid, except near the optic nerve. When removed, this surface of the choroid presents a smooth, glistening appearance, like a serous membrane; and we have already stated that some suppose a fine serous sac to exist between these two coats, one lamina lining the sclerotic, the other investing the choroid; this appearance, however, rather depends on the fine and serous character of the connecting areolar tissue, which, when divided during the separation of the coats, presents a

smooth, shining surface on each. The dissector may now easily detach patches of this external or venous lamina of the choroid membrane, particularly posteriorly. The choroid membrane should next be divided circularly about half-way round the eye, also from before backwards, and the angles carefully turned off the retina; a gentle stream of water will wash off the internal pigment, and the inner surface of the membrane will be exposed. If the head have been minutely injected, either veins or arteries, the vascularity of this surface, called "Membrano Ruyschiana," will be very conspicuous, or when suspended as a preparation. When viewed with a lens, the surface appears villous and the vessels extremely minute, forming a fine capillary network, without any peculiar arrangement of veins, as upon the outer surface. When the whole of this membrane is separated from the retina, and one part thrown backwards, the other forwards, we see in the concavity of the former the free circular aperture for the optic nerve; but anteriorly, as it approaches the ciliary ligament, to which its external lamina is closely attached, we perceive its concave surface presenting small folds or plicæ, which are the commencements of the ciliary processes, to be described presently. If the sclerotic and choroid be separated in a recent eye, and the latter also partially detached from the retina, the pigment will attract attention. In man this is of a dark brown color, but in most animals it is a deep black; the interior of the sclerotic is stained by it, but not the retina; it seems to pervade the entire of the choroid, but coats it more thickly internally, and is thicker and of a deeper color posteriorly and anteriorly than laterally; it is not confined to the choroid, but abounds on the back part of the iris and on the surface of the ciliary circle. In many animals also there is a black rim of it around the cornea, and in the border of the nictitating eyelid; also in the marsupium in the bird, and in other detached situations. It is of a deeper color in the child, but does not stain the sclerotic so much as in the adult; it is less in quantity, and of a paler color, in the old. Its tint differs in different individuals, and probably bears some proportion to the general complexion; in some, as albinoes, it is altogether absent, and vision is defective in consequence. If the recent choroid be agitated in water, the pigment does not render the fluid turbid, and is not detached, and sometimes can be peeled off in small pieces; but after a few days' maceration, or when decomposition has set in, it mingles with the water, and can be washed off, leaving the choroid, if uninjected, of a gray or whitish color; this is probably owing to the pigment being inclosed in fine cells, which do not rupture for some time after death. Some consider the pigmentary layer of the choroid as a distinct organized membrane (*see* a Paper by Wharton Jones, Edinb. Med. and Surg. Jour., July, 1833), composed of hexagonal plates disposed in regular mosaic order; in these the pigmentary particles are deposited, and even if the pigment be absent the membrane will still exist. The fact, however, of its being deposited in so many situations, and so variably in some animals, would indicate that the vessels in any part of the orbital region, even in the sheath of the optic nerve, may separate the pigmentary cells without the intervention of a distinctly organized membrane. Dalrymple (Anat. of the Eye, p. 96) describes a fine serous lamina as covering the inner surface of the pigment, a continuation or reflection of the external tunic of the retina, or the membrane of Jacob. Henle gives a full account of the microscopical appearances of these pigmentary cells, and the history of the various opinions entertained as to their anatomical structure and development (which *see*, Anatom. Gen., p. 300). This peculiar animal secretion is designed to darken the interior of the eye in the same manner as the inside of the microscope and telescope is blackened, to absorb the rays of light, and to prevent their being reflected back again to the retina; it also renders the forepart of the sclerotic and all the

iris opaque, and thereby obstructs the light entering through any part of the globe except through the pupil.

In many animals, as the sheep, ox, horse, and in most of the carnivora, the pigment is not apparent at the bottom of the eye, and the choroid presents a beautiful bronze or metallic lustre of various tints, green, blue, yellow, and white; this appearance is named *tapetum;* it occupies nearly one-fifth of the eye, commencing at the outer side of the optic nerve, and extending forwards to an irregular distance, and terminating by an undefined edge: but little of it appears on the nasal side of the globe, the pigment overlaps its border, and sometimes to an irregular extent, and more in the young than in the adult animal, as I find in comparing it in the lamb and sheep; it is not so brilliant in the pig as in the horse; in the elephant it exists, but is very much concealed by the pigment. The tapetum resembles the brilliant metallic tint of some nacreous shells, and the colors probably depend, not on any coloring principle, but on some peculiar arrangement in the structure or surface of the inner lamina of the choroid, whereby the rays of light are decomposed, some colors absorbed, and others reflected, in the same manner as Sir D. Brewster has shown (Phil. Trans., 1814, p. 397) that the iridescent colors in mother-of-pearl depend on the parallel grooves in the structure, and can be transferred to any material taking an accurate cast of the surface. On removing the tapetum, in the sheep, I find the black pigmentary membrane is perfect behind it.

Ciliary ligament is a soft, spongy, fibro-cellular annular band, of a grayish white color, about a line and a half broad, not stained by pigment, situated on the anterior and external borders of the choroid membrane, and intimately adhering to and continuous with its external lamina, internal to the line of junction of the cornea and sclerotic, to which also it adheres, and external to the circumference of the iris, which is inserted into it; while from its internal and posterior aspect are continued the ciliary processes or folds of the choroid membrane, which are attached to the back part of the iris and to the forepart of the vitreous humor. It thus serves as a common central medium to connect these several tissues, and to fix them steadily in their relative situations; it strengthens the attachment between the cornea and sclerotic, and confines the latter so closely to the choroid that the aqueous fluid cannot possibly penetrate between them; its white color forms a striking contrast to the black ground of the choroid and to the variegated tint of the iris. In the minutely-injected eye it is not colored, but the ciliary arteries from behind, and small branches which pierce the sclerotic in front, perforate it in their course to the iris; the ciliary nerves also enter it, subdivide in it, and can be traced through it into the iris. From the connection of these nerves to it, it was regarded by Somering and others, but incorrectly, as a nervous ganglion. Its use appears to be principally mechanical, and there is no proof to support the different opinions that have been entertained by different writers as to its glandular, muscular, tendinous, or nervous structure. A small circular canal has been described in it by Fontana; this appearance most probably arises from a circular bloodvessel or inosculation.

Ciliary processes, or corpus ciliare, are delicate folds or plaits of the choroid membrane extending from within the ciliary ligament to the back part of the iris, and thence along the forepart of the vitreous humor to near the circumference of the crystalline lens. These may be exposed either anteriorly by removing the cornea and one-half of the iris, or from behind by making a transverse section of the globe; and, looking forwards through the transparent vitreous humor, the student should examine them in both these aspects, also in different sections of eyes preserved for a few days in spirits; they are small, triangular processes, between sixty and seventy in number, from a line to two lines in length, and alternately long and short; each process is a fold

or plait of the inner layer of the choroid, arising small and narrow; advancing forwards it increases in size, and is attached by its anterior extremity to the back part of the iris or uvea, while its internal border extends inwards in front of and depressed into the hyaloid capsule of the vitreous humor, around and at a little distance from the circumference of the lens; between each pair of processes, thus attached to the hyaloid membrane, a similar process from the latter extends, and is intimately attached to them, the one being dovetailed between two others. The entire series resembles the disc of a radiated flower, placed behind the iris and partly connected to it, its external circumference attached to the ciliary ligament, its internal or lesser circle surrounding the lens, and presenting the fringed points or processes, between which are the corresponding folds of the hyaloid membrane; these complete the posterior wall of the posterior aqueous chamber, and are separated by its fluid from the iris. If these processes or rays be considered as each of a triangular form, their apices or loose points will form the lesser or inner circumference; their posterior and inner borders rest in the hyaloid membrane; their anterior borders correspond to the aqueous fluid internally, and to the iris externally, and the plicated root of each from the choroid may be regarded as its base. The surface of all these processes, as well as of those of the hyaloid membrane, are deeply tinged with pigment; if this be washed off, they are of a grayish color, and their surface is villous and highly vascular; when minutely injected they resemble the choroid tissue, with which they are continuous. The extremities of the processes do not touch the border of the crystalline capsule: in the very recent eye a small, clear circle of the hyaloid and vitreous humor, surrounds the latter between it and the ciliary body. If the choroid and its ciliary processes be removed from the forepart of the hyaloid membrane, the depressions which they occupied are perfectly free from pigment; but there still remains another dark and radiated disc, formed by the projecting processes of the hyaloid membrane which were inserted between those of the choroid; the points of these processes are directed outwards, the reverse of the former. Different opinions have been entertained by different writers as to the nature and office of the ciliary processes; some have supposed them to be muscular, and capable of effecting focal changes in the eye; others that they are of an erectile, venous tissue, and concerned in the motions of the iris. Ribes considers them as the secreting agents of the aqueous humor. There is little doubt, however, that they are essentially vascular, and serve to secrete the black pigment in a situation where it is much required; they must also strengthen the connection between the choroid, the iris, and the hyaloid membrane, and thus complete the boundary of the posterior chamber of the eye.

Iris is the circular, vertical partition seen behind the cornea and in front of the lens, dividing the intervening space which contains the aqueous humor into two chambers, an anterior and posterior; it floats and can move freely in this medium, and the two chambers, which it partly separates, communicate with one another through its central aperture, named the *pupil*. This opening is a little nearer the nasal than the temporal side of the iris, which is consequently broader on the latter aspect than on the former. The pupillary opening is circular in man, but is oblong transversely or vertically in many of the lower animals; in some, also, delicate fringed processes float from its edge; its size varies according to the distance of the object in view, also according to the sensibility of the retina, and, above all, according to the intensity of the light admitted into the eye. When the object of vision is very near, the retina very sensible, and the light strong or bright, it is contracted; under opposite circumstances it is enlarged; these changes occur with great rapidity, and there is also good reason for believing that volition can influence them. The external border or circumference is inserted into the ciliary liga-

ment, or rather between it and the ciliary processes, and corresponds to the junction of the cornea with the sclerotic. The anterior surface is flat, though in dissection it appears a little convex as it falls unsupported upon the lens. This surface presents the well-known varieties as to color, dark brown, hazel, gray, blue; hence its name, iris or rainbow. The shade towards the pupillary margin often differs from that of the general surface in being much darker; these shades probably depend, partly on its variable density and the black pigment on the back of it partially appearing through it, and partly on irregularities on its surface decomposing the light and reflecting certain colored rays and absorbing others; its vascularity, also, may have some effect. There is often a correspondence between its color and that of the hair and complexion: in most fish it presents a metallic lustre. The posterior surface is coated with a thick lamina of dark pigment, and from a fancied resemblance to the ripe purple grape, has been named *uvea*. The iris is highly organized, receives its blood posteriorly from the long ciliary arteries, and anteriorly from the ophthalmic. The long ciliary have been already seen, between the sclerotic and choroid membranes, proceeding forwards, one on the nasal, the other on the temporal side, parallel to the equator oculi. Having arrived at the circumference of the iris, each divides into two diverging branches; these form a circular inosculation, which is joined by the anterior branches from the muscular arteries of the ophthalmic, and from this are derived numerous branches which converge into the iris, and again inosculate; and, finally, minute tortuous capillaries radiate inwards to the pupillary margin. In a minutely-injected eye the iris is found to be very vascular, but is seldom equal to the choroid membrane or ciliary processes: its veins return the blood either into the vasa vorticosa or into some of the ciliary. The nerves of the iris are derived from the ophthalmic ganglion, that is, from the nasal branch of the ophthalmic or sentient division of the fifth, and from the third, the chief motor nerve in the orbit; the former is also connected with filaments of the sympathetic, which latter communicate with the orbital plexus. The ciliary nerves, about twelve or fourteen in number, are seen to pass through oblique canals in the sclerotic, and then to proceed forwards on the surface of the choroid. with the dark color of which they form a striking contrast; and in the ciliary ligament they divide into small branches, which become soft and indistinct, and disappear in the iris. To examine the structure of this organ it may be removed from the eye: it is thicker and stronger than the choroid membrane; its anterior surface presents a very irregular appearance, as is well seen in the living eye, projecting lines, with intervening depressions, interrupted by slight projections; these lines mostly radiate from near the pupillary margin towards the circumference; some are straight, others tortuous; some interlace and bifurcate, and others appear to stop in small projections. When the pupil is contracted these lines are more distinct and straight, but when dilated they appear more tortuous and interlaced. This structure is now very generally considered muscular, and is compared by Jacob (Med. Chirurg. Trans. vol. xii.) to the carneæ columnæ and chordæ tendinæ in the heart. Some, however, have contended that this surface is villous, and that the lines and striæ just mentioned are radiating vessels and elastic fibres; their appearance, however, bears no resemblance to arteries, either in size, color, or inosculation. The border of the pupil is surrounded by a narrow circle of fibres, which can be better seen on the posterior surface; these are also considered muscular, and have been named the constrictor or sphincter iridis (Cloquet). It is to be presumed that the anterior surface of the iris is covered by the fine membrane or capsule of the aqueous humor, although it cannot be distinctly demonstrated. The posterior surface, or uvea, is of an uniform deep brown or black tint; when recent, the pigment does not stain the finger, being covered and retained in this situation by the fine membrane of the aqueous humor;

when this and the pigment are removed and washed off, the back of the iris is of a grayish color, and presents a number of minute plicæ, or lines converging towards the centre; the pigment adheres to these folds and depressions. Around the pupil the circular ring is more obvious than in front; into this the anterior radiated fibres are interwoven in a manner analogous to that in which the muscles of the face are interwoven with the orbicularis oris (Dalrymple, p. 50). This twofold order of muscular fibres, supplied by compound nerves, appears fully adequate to explain the functions of the iris. When required to contract, the sphincter fibres close the pupil almost to a point; when enlargement is necessary the sphincter relaxes, and the external or radiated fibres act, and enlarge the opening to the necessary extent; and thus the great design of the iris and pupil is effected, namely, to regulate the quantity of light to be admitted: the pigment on its posterior surface prevents the transmission of any rays external to the pupil. The iris may also assist in the correction of spherical aberration, by the contraction of the pupil excluding all the circumferential rays; and some also have considered it capable of acting, through the ciliary processes, on the hyaloid membrane and lens, so as to adapt the eye to vision at different distances.

During the greater part of uterine life the pupil of the fœtus is closed by a delicate membrane, *membrana pupillaris;* it is most distinct about the fifth month, and is found to consist of two thin membranes, extended from the surfaces of the iris and separating the anterior from the posterior chamber. These membranes are transparent in the centre; but on either side are seen, in an injected preparation, small vessels forming arches or loops; those of opposite sides are said not to anastomose, but from a preparation now before me I consider this assertion very doubtful. It has been also atated that these membranes give way towards the centre about the seventh month, and that the rupture is caused by the retraction of the vascular arches. This description, however, has been rendered more than doubtful by the researches of Jacob (Med. Chir. Trans., *loc. cit.*), and more lately by others, who have proved that the rupture does not occur until near birth, and sometimes not for some time subsequent to it; and that it gives way not by a rent or fissure, owing to the retraction of the vascular loops, but that it gradually loses its vascularity, becomes thin and delicate, and is finally absorbed, often leaving ragged remnants on the margin of the pupil. The membrana pupillaris may be considered as formed by the apposition of the two fine serous sacs which line the two chambers of the eye, one in front of the iris, the other behind it; the vessels of the iris extend between these membranes towards the centre, and are arranged in the peculiar loops or arches already noticed, those of opposite sides occasionally, but probably not constantly or normally, inosculating with each other. As the iris increases in size and thickness by the process of nutrition, the vascular loops become more closely connected to it, the central partition becomes thin, atrophied, and absorbed, and finally is opened, the remnants soon disappearing, and the two chambers of the eye then permanently communicate through the pupil. Cases have been recorded where this atrophy has not taken place, and where blindness has been the result of a permanent membrana pupillaris. The state of this particular tissue, or the change it undergoes, has not yet been fully examined in other animals.

Retina is the third or innermost, or the nervous tunic of the eye, and in immediate contact with the vitreous humor which distends the posterior part of the globe; it is concentric to, but of less extent than the sclerotic or choroid; it is the most important and interesting constituent in the organ, as it alone is sensible to the impression of light. During life. and for a few hours after death, it is transparent, but soon becomes opaque and milky; it is an extremely thin and delicate tissue, and care and experience are required in the dissection necessary to expose it. Gently tear off the choroid membrane,

the eye being secured under water on a plate of glass, and then place an inverted glass globe, filled with clear diluted spirits, over the dissection, which becomes magnified, and the retina presents a semi-opaque, whitish appearance, not unlike ground glass; it is the expansion of the optic nerve into a membrane forming a portion of a sphere, and extended between the choroid coat and the vitreous humor, accurately fitting between these and adhering to the capsule of the latter; the optic nerve pierces the posterior part of the globe, or of the two preceding tunics, about a line and a half internal to the centre, or to the antero-posterior axis, and then expands into this delicate, semi-transparent tissue, composed of membraneous, vascular, and nervous tissue, which extends as far forwards as the posterior extremities of the ciliary processes, and about the eighth of an inch behind the ciliary ligament, and ends in a defined, serrated, or undulating margin, corresponding to that of the ciliary body. The concave surface of the retina may be exposed by making a transverse division of the globe in front of its centre. and removing the lens and vitreous humor; the optic nerve will be then seen at the bottom of the eye as a circular spot, in the centre of whch is a dark point, "porus opticus;" through this the small artery, named "centralis retinæ," passes; this immediately divides into diverging branches, which ramify on the internal or vascular layer of the retina, and can be traced as far as its anterior border, where they form a circular inosculation, and probably communicate with the vessels in the ciliary processes. In the very recent human eye, or in those of large animals, these vessels are often beautifully injected with red blood; the centralis retinæ also gives off one delicate branch posteriorly, which passes forwards through the centre of the vitreous humor, and reaches the back part of the capsule of the lens. This branch can be seen in the eye of the ruminant when very recent; it can also be injected in the human fœtus. The central artery of the retina not only supplies this membrano-nervous expansion, but must also nourish the hyaloid capsule of the vitreous humor; the latter, also, most probably receives an additional supply anteriorly from the vessels of the ciliary processes. As the optic nerve spreads out into the retina, the medullary fibres or fasciculi, diverging and expanding, are at first very evident in the eyes of some animals, as the ox, hare, and rabbit, and, as I have lately seen, in the elephant; but in the human eye the fasciculi are not distinct, a few radiating lines only can be observed in the very recent state; one such line may be observed leading outwards from the entrance of the nerve to a point about a line and a half distant, which exactly corresponds to the axis of the eye; at this point there is a small circular or oval spot, with a dark centre and a yellowish border. This was first noticed by Soemerring, and has since been named the *foramen*, or *spot of Soemerring, aureum punctum*, &c. It has been observed in the human eye, and in that of the quadrumana, that is, according to Cruveilhier, in those animals whose visual axes are parallel; but it has been also found in some reptiles, to which this observation cannot apply; it is not seen in the horse, ox, or other mammalia, nor in birds or fish; it is faint in the child and in old age, deeper in youth and middle life: it is well marked in those who have died suddenly between twenty and thirty years of age. We have seen it beautifully distinct in the eyes of some young men executed in Dublin some years since. Soemerring considered this spot as a perfect foramen, or deficiency in the retina; minute examination, however, shows that there is no actual hole or interruption in the tissue; and when the retina has been carefully dissected and suspended in a clear fluid, although in the course of a few days the spot disappears, yet there is no opening or deficiency, nor indeed any peculiar appearance, observable in the situation it occupied, whether viewed on the concave or convex surface: most probably it depends on slight folds or projections, with an intervening depression at that particular point, and which are gradually effaced;

there may also, perhaps, be some peculiar vascularity or organization in that situation, which, however, has not yet been ascertained. Sir E. Home fancied that an absorbent vessel passed through it.

Although the retina at first view appears a homogeneous, soft, and delicate pulpy nervous expansion, it is found to consist of three tissues, each differing in texture and function; it was long considered as composed of two laminæ, an internal vascular, and an external nervous. In the year 1819, however, Dr. Jacob discovered the existence of a fine membrane, of a serous or sero-cellular nature, external to the nervous: an account of this was first published in the Philosophical Trans. (1819), and has been reprinted in Todd's Encyclop. of Anat. (art. "Eye," p. 186). This lamina, now named *tunica serosa*, or Jacobi, is the external layer of the retina; it supports the nervous tissue on that aspect, and separates it from the pigmentary surface of the choroid. The internal lamina of the retina is a fine vascular membrane, essentially composed of the minute capillaries of the arteria centralis; this supports the nervous matter on its internal or concave aspect, and separates, but at the same time connects it in its proper expanded form to the convexity of the vitreous humor. The first, or the *lamina serosa*, is an extremely delicate and soft tissue, but is now recognized by most anatomists as a perfect membrane. Cruveilhier states he has not been able to demonstrate it; it, however, no less exists; but to exhibit it, the directions of its discoverer must be followed: "Place the recent eye under water, fastening it to a piece of wax attached to the bottom of the vessel, having first removed the posterior half of the sclerotic; then, with a pair of forceps in each hand, gently tear and turn down the choroid; instead of the blue, white, reticulated surface of the retina, the eye now perceives a villous surface, more or less tinged with pigment: press the handle of the knife gently against this surface, so as to make a breach in it, and a very delicate membrane may be separated, and thrown in folds over the choroid, or a blunt probe may be introduced between it and the nervous layer, remaining loose over the latter; a particle of air or paper, or a few globules of quicksilver, may be introduced beneath it, and thus render evident its membraneous nature, leaving the retina uninjured." It extends from the optic nerve to the ciliary processes, is firmer in the adult than in the child, and adheres more closely to the pigment; it is connected to the choroid by fine cellular tissue and vessels, but is more intimately attached to the retina. Mr. Dalrymple considers this membrane as a perfect serous sac, one lamina adhering to the retina, the other to the choroid membrane, and reflected from one to the other at the ciliary circle anteriorly, and at the entrance of the optic nerve posteriorly (p. 100). The internal or *vascular layer* of the retina may be considered as analogous in function to the pia mater on the brain, but is so fine and delicate that it is extremely difficult, indeed impossible, to demonstrate it as one continuous structure; it adheres externally to the nervous lamina, and internally to the hyaloid membrane. If the vitreous humor, with the retina, be allowed to remain in water some days, the nervous matter may be gently rubbed off, and this vascular layer or tissue may then be gradually and partially separated from the hyaloid capsule, and left suspended from the optic nerve. When uninjected it is perfectly transparent; it is essentially composed of the capillary ramifications of the centralis artery and vein. The *middle layer* of the retina is the expanded medullary or fibrous substance of the optic nerve; a fibrous arrangement or structure is not obvious. Treviranus, however, has described it as consisting of cylindrical fibres or tubes of unequal length, which, proceeding from the optic nerve in all directions, bend obliquely inwards through the vascular layer, and each terminates in the form of a papilla on the vitreous humor. Different opinions have been entertained as to the extent of the retina anteriorly the nervous layer obviously ends in an undulating border at the commence-

ment of the ciliary processes, about a quarter of an inch external to the border of the lens, while the vascular or inner layer appears intimately attached to the hyaloid membrane and ciliary processes. Many, however, have described this layer as continued to, and in front of the capsule of the lens; the connection, however, between the choroid and hyaloid ciliary processes must prevent any such extension.

The several tunics that have been described form the parietes of the eyeball, but its cavity is occupied and distended by substances of a totally different character, the humors, or the dioptric or refracting media, three in number, each differing from the other in quantity, consistence, and refractive power, but all equally transparent; they are the aqueous, the crystalline, and the vitreous, and are placed in that order between the transparent cornea and the optic nerve.

Aqueous humor occupies the space between the cornea and the lens, is perfectly colorless, and consists of a fine secreting membrane or capsule and the secreted fluid; the latter is transparent, about five grains in amount; in specific gravity and other properties it differs but little from water; 100 parts contain about 98 of water, the remaining are chloride of sodium and a minute portion of albumen. The *membrane* of this humor is one of the most delicate textures in the organ, and its existence in some situations is rather inferred from analogy than proved by actual observation; it secretes and retains this fluid, and forms the parietes of the space it occupies; this space is divided by the iris, which floats in this fluid, into two chambers. The *anterior* is bounded by the concave surface of the cornea in front, and by the flat surface of the iris behind. The *posterior* is much smaller, and of a more irregular form; the iris bounds it anteriorly; posteriorly it is bounded by the lens, with its capsule in the centre; external to this by the hyaloid membrane, forming a very narrow, but clear circle around the lens; and more externally by the extremities of the ciliary processes: the circumference is formed by the ciliary processes extending from the vitreous humor to the back of the iris. These two spaces, of which the anterior is much the larger, communicate freely through the pupil. The membrane or capsule of this fluid lines the cornea, is thence continued over the front of the iris and around the pupillary margin to its back part, where it can be distinctly raised off from the uvea; thence it passes over the ciliary processes, the hyaloid membrane, and the forepart of the crystalline capsule.

Crystalline humor is a transparent double convex lens, the posterior convexity greater than the anterior; the former forms part of a circle of four or five lines diameter, the latter of one from seven to eight lines. These relative proportions, however, are by no means regular; neither is it possible to obtain accurate measurement of its curves, as its surface is soft and semifluid, and must undergo some change in the process of removal. In the fœtus it is more spherical; in youth and middle age the anterior and posterior convexities are more considerable, but these decrease in old age. The lens is imbedded in the forepart of the vitreous humor, at the junction of the three posterior with the anterior fourth of the eyeball, and a little nearer to its nasal than to its temporal side. Its axis corresponds to that of the pupil; it is retained in its situation by the connection between its capsule and the hyaloid or vitreous membrane posteriorly and circularly, and by the membrane of the aqueous humor, which passes over it, anteriorly. The crystalline humor, like the other humors, consists of a capsule and the contained substance; with this difference, however, that both the aqueous and vitreous fluids are secreted by their investing and containing membranes, and are not themselves organized; but the lens is of much greater consistence, and presents a complex structure, and, no doubt, possesses the requisite degree of organization. The *capsule* is eminently transparent, but dense and elastic, not unlike the

posterior layer of the cornea; its transparency is not affected by boiling or immersion in alcohol, and, although the lens has been rendered opaque thereby, yet the thin, transparent capsule may then be separated. This elastic capsule may serve to preserve the form of the lens, just as the posterior layer of the cornea preserves the curvature of that tissue; and as we conclude from analogy that the latter is lined by the aqueous membrane, so we infer that the forepart of this capsule is covered by the same. This capsule is connected posteriorly by a fine, areolar, and vascular tissue to the hyaloid membrane. In finely injected preparations the central artery of the vitreous humor may be seen to ramify on its back, and probably fine vessels from the cilary processes extend to it laterally and anteriorly. The organization of the capsule may also be inferred from disease; it not unfrequently becomes opaque, and constitutes capsular cataract. On opening the anterior part of the capsule in the eye long dead, a small quantity of fluid escapes; this has been generally named "liquor Morgagni," and has been considered by many as constantly interposed between the lens and its capsule. It is much more probable, however, that the presence of this fluid is a *post mortem* occurrence, because it is not found in the eyes of the larger animals when recent; indeed, in the eyes of sheep and oxen, from which I had removed the cornea, and of course the aqueous humor, I have not found any aqua Morgagni at the end of a week; neither is it present in the human eye, if examined a few hours after death. Were any such fluid naturally and constantly present, it must insulate the lens from its capsule, so that the former should be regarded as an inorganic mass, inclosed in the capsule, like the aqueous humor. This, however, is not only improbable, but is opposed by the fact that if a recent eye be carefully examined, without bruising or injuring it, the cornea and iris removed, the capsule freely opened anteriorly, the lens may be pressed with a probe or handle of the knife with some degree of force before it is dislocated; or, if the eye be suspended by the nerve, the lens will not fall out of the open capsule. This connection is certainly more conspicuous posteriorly and circularly than anteriorly; there can be no doubt that this connection is of an organized nature, and thereby the lens itself receives its nutrient vessels and nerves. When the *lens* is separated from its capsule, it is found to be perfectly transparent; it sinks in water slowly, as its specific gravity exceeds it but little; its weight has been stated at four grains, its diameter about four lines, and its axis about two: its circumference is not circular, but a little elliptical. It has been already stated that its form, as well as its density, vary at different ages; these also, no doubt, vary in different individuals of the same age, which may partly account for the different power of vision enjoyed by some compared with others, deficient convexity producing presbyopia, and an excess of it causing myopia. In the fœtus it is often of a reddish or pinkish tint; in the adult it is perfectly clear; and in the old it is often of an amber or light brownish hue. The density of the lens is obviously less upon the surface than towards the centre, and this difference is more marked in the old than in the young; the centre is firm and consistent, like a piece of gum arabic, and is named the nucleus. From this to the circumference the consistence diminishes, and the surface is semifluid, but the whole is more dense that either of the other two humors. According to Berzelius, the lens consists of water, 58.0; peculiar matter, 35.9; hydro-chlorates, lactates, and animal matter, soluble in alcohol, 2.4; animal matter, soluble in water, 1.3; insoluble membraneous matter, 2.4. Chenevix states that it contains both gelatine and albumen, and, when reduced by heat to ashes, distinct traces of iron are found; there is no trace of fibrine. That the lens is not a simple, homogeneous mass, but a very compound or complex structure, is obvious from examination. What this precise structure is, is not perfectly ascertained, and various opinions have been entertained upon the

subject. When boiled, it can be separated into concentric layers, of which the external are soft; the internal increase in hardness to the central nucleus. These laminæ appear to be composed of parallel fibres, united to each other by indented margins: during the separation of these lamellæ the whole will part under moderate pressure into three triangular or cuneiform segments, their bases towards the circumference, their apices towards the centre. Simple maceration in cold water for two days will cause the lens to become opaque and fissured, and by degrees it expands into a soft, laminated, and fibrous tissue. The laminæ of fibres are wonderfully thin, and have been differently described as to the order in which they are arranged. Sir D. Brewster has described their appearance with great accuracy, and has observed a difference in their arrangement in different animals. In man the structure is the most complex: the three septa diverge from each pole, the septa of the posterior surface bisecting the angles formed by the septa of the anterior surface. These fibres, under the microscope, appear united by a series of fine teeth, those of one fibre locking into those of another. The minute structure of this organ, according to this author, cannot be well understood without reference to his illustrations, and the limits of this work do not permit of more extended remarks upon a subject which cannot be well pursued in the ordinary practical course of study in the dissecting-room. I, therefore, refer the reader to his paper, Phil. Trans., 1833.

The *use* of the crystalline lens is well established.

Vitreous humor, or *hyaloid body*, fills the posterior three-fourths of the globe, and is in contact with the whole of the inner surface of the retina, which it supports in its expanded form; anteriorly and centrally the lens is imbedded in it, and more externally the ciliary processes are attached to it; it is, therefore, of a spheroidal form, truncated in front. In the adult it is perfectly transparent, but in the fœtus has a rosy tint; it is gelatinous or semifluid, and of a medium degree of consistence, and therefore, of refractive power, between the aqeous and crystalline humors. It consists of a fine, transparent, membraneous capsule and areolar tissue, secreting and inclosing a fluid like water. The membrane is named, from its transparency, *hyaloid capsule* (υαλος); it not only incloses the humor, but also sends inwards numerous processes, which join each other, and form a fine areolar or cellular tissue, in the interstices of which the fluid is confined; thus the vitreous differs essentially from the aqueous fluid, the latter being contained in one capsule, the former in numerous cells which communicate with each other. If the hyaloid membrane be punctured and suspended, the fluid escapes drop by drop, and the whole will be gradually discharged; if a blowpipe be then introduced into it, the membrane may be inflated and dried, and its cellular texture will become evident. Immersion in alcohol or acid will render the membrane opaque, and thus also display the numerous internal septa. It is said that freezing the mass affords an opportunity not only of distinguishing the membraneous cells from the congealed fluid, but also of ascertaining the precise figure of the former. My own experience, however, does not confirm that assertion; in the frozen mass I have not been able to distinguish any difference in structure, or any peculiar arrangement of parts. The *vitreous fluid*, when collected separate from the membrane, differs in no essential respect from the aqueous, being composed of water and about two per cent. of animal and saline matter. The vitreous body is traversed by a small artery from the centralis retinæ, which proceeds in a tortuous course from behind, and is lost on the back of the capsule of the lens; it only transmits the colorless parts of the blood, and, though principally destined to the lens, it most probably assists in the nourishment of the hyaloid membrane. The vascular layer of the retinæ, which is attached all around its convex surface, also sends into it vessels, and, most probably, nerves; and anteriorly the ciliary processes

of the choroid assist in the same object. Into the depression in front, the lens, with its capsule, is accurately fitted and intimately attached; and all around this body the hyaloid membrane presents a number of folds or plicæ, which correspond in number to the ciliary processes of the choroid, into the intervals between each pair of which one of these hyaloid processes is received, and an intimate connection exists between them. These also, like the choroid ciliary processes, are stained by pigment, so that the vitreous body presents in this situation the appearance of a radiated disc or zone, which has been named the *corona ciliaris*, or the *Zonula of Zinn*. It is a dark, radiated circle, concentric to the lens, but at a slight distance from its circumference; between the margin of which and the corona ciliaris a narrow, transparent circle, about the eighth of an inch wide, is seen. This disc is a little broader on the temporal than on the nasal side; like the iris, it serves to exclude the admission into the interior of the eye of lateral rays of light, and it may also absorb any slanting rays which may have passed through the pupil too obliquely to be refracted to a proper focus by the lens.

If the end of a fine blowpipe be inserted under the hyaloid membrane, where it forms the corona ciliaris, between this and the margin of the lens, and a little air injected gently, a number of fine cells will become distended, presenting a circular, beaded appearance around the lens; this has been named the *canal of Petit*, or *godroné*, the exact construction or mode of formation of which it is not easy to determine; it is generally supposed to be formed by the splitting of the hyaloid membrane at the margin of the lens into two laminæ, one passing in front of and the other behind the capsule of that body, and thus bounding a sort of triangular sinus, the base being the margin of the lens, the apex being the hyaloid membrane at the point of splitting, and the sides being the two laminæ; the beaded appearance being caused by imperfect septa passing from one lamina to the other, through which the air may be impelled from cell to cell. It is probable that these septa also extend across the inner end of each cell, even more perfectly than between them; for, as Jacob has remarked, if the canal be injected with air, and the lens and capsule very carefully removed, the air will be still retained, which proves the existence of some membraneous partition between the cells and the surface of the lenticular capsule.

From the preceding description it must appear that the eye is not only of complex structure and delicate organization, but is also a refined optical instrument. The rays of light proceeding from any object strike upon the surface of the cornea, which, being convex and much more dense than air, refracts them, and causes them to converge towards a distant focus. In passing through the anterior chamber this convergence is slightly counteracted, and the degree of refraction is about equal to that which would have occurred had they impinged at once upon the convex surface of the aqueous humor, supposing the cornea not to have been interposed. Much of the light that traverses this fluid falls upon the iris, which, like the stop or diaphragm in any optical instrument, excludes it, and this light is reflected back again through the cornea; hence we see the fibrous texture and variegated color of the iris when we look upon the eye of another. Those pencils of rays only which pass through the pupil are subservient to vision. As these pass through the lens they undergo two refractions, because this medium is convex on both surfaces, and is more dense than either the aqueous or vitreous humor. These refractions increase the convergence of the rays, and bring them to their proper focus upon the sentient surface of the retina, on which is formed an accurate image of the various external objects from which the rays of light have been received. This image is inverted; what is above in the object is below in the image; the right side of the object is to the left, and the left to the right, while the relative position of its different parts remains the

same; but as all surrounding objects, if seen, must be equally reversed, the relative position of all objects, therefore, remains unchanged, and there can be no comparison between what is erect and what is inverted, and, therefore, the sense acquires a correct idea of the position of objects. The fact, however, of our seeing objects erect, notwithstanding their images are inverted on the retina, as also that of single vision, from the simultaneous action of both eyes, and many other phenomena, have given rise to some interesting inquiries and to much speculation respecting the functions of the retina and optic nerves; but these questions do not receive elucidation from anatomy, and their consideration rather belongs to the writer on physiology.

As the accurate convergence of all these pencils of rays to their respective foci upon the retina is necessary for the formation of a perfect image, and for clear and distinct vision, certain nice adjustments in the apparatus are required, and have accordingly been supplied, and which in artificial optical instruments are attained with difficulty by mechanical skill. An image of an object, formed by a simple refracting medium, is liable to certain imperfections or aberrations of light: these are principally three, and are technically termed, first, aberration from sphericity; second, from parallax; and, third, chromatic aberration. Each of these we shall briefly explain, with a view of considering how they are obviated in the living eye.

Aberration from sphericity arises from this cause: a refracting spherical surface does not unite the parallel or diverging rays of a pencil exactly into one focus, because the lateral rays converge sooner than the central; hence arises a certain degree of confusion, which requires much attention to correct in the construction of the microscope or telescope. This correction is effected in the eye partly by the iris shutting off all circumferential rays, and partly by the form and texture of the lens; its surfaces are not spherical, but elliptical, and it is more convex posteriorly than in front; its density also increases from the surface to the centre, and, as the refractive power is proportioned to the density of the medium, so the rays, which pass through and near the centre, are brought to a focus sooner, and thus accord with those which are refracted more externally, and thereby that defect is obviated which occurs in lenses of uniform density.

Aberration from parallax may be thus explained. When the object viewed is very distant, the rays of light from it may be considered as nearly parallel; but, when the object is very near, the rays from it diverge considerably in their course to the eye. The effect of refraction on the distant or parallel rays is to bring them to a focus very near the lens; but the near or diverging rays are collected into their focus at a greater distance from it; the more remote the object, the nearer will the focus be to the lens, and for every distance of an object there is a corresponding focal distance behind the lens. If, therefore, the eye be adapted for vision at one particular distance, the images on the retina of objects at any other distance ought to be confused, because the foci will be formed either before or behind the retina; in the latter case this membrane will interrupt the rays in their course, and in the former it will not receive them until they have crossed each other in passing through their focus. This optical defect is counteracted by a power which the eye possesses, named *adjustment*, or accommodating itself to vision at different distances. The immediate agency in this power is not exactly ascertained, but most probably it depends on a vital energy of some of the textures in the globe; it has been ascribed by some to the fibres of the lens being muscular, and capable of altering its form, density, and distance from the retina; by others to a change in the convexity of the cornea, or to an alteration in the form of the globe by the compression of the surrounding muscles, or to a change in the position of the lens through the action of the iris and ciliary body, or through the contraction or erection of the ciliary processes.

Chromatic aberration depends upon the fact that rays of white light are composed of differently colored rays, red, orange, blue, &c., which are partly separated or dispersed by refracting media; and, as some colored rays are more refrangible than others, they will converge sooner; thus blue and violet are more refrangible than red or orange, and will sooner be brought to a focus, and thus the distinctness of the image will be impaired or confused, and fringed with different tints. This defect, which is termed chromatic aberration, is obviated in the eye by the employment of several refracting media, each of different density, and even of different chemical composition. Thus the lens has two unequally convex surfaces, each of which differs in density from its more central portions; the cornea and aqueous fluid form a refracting medium of different consistence from the lens or vitreous humor, and it is probable that the dispersive power of these may be disproportionate to their refracting effect, whereby an achromatic combination is established in the eye, as is effected in optical instruments, by combining lenses of different materials: we are not, however, to conclude that the eye is perfectly achromatic.

The two well-known defects in vision, *myopia* and *presbyopia*, depend either upon some peculiarity in the refracting media, or upon a deficiency or weakness in the power of adjusting or accommodating the eye to vision at different distances. Myopia, or near-sightedness, may be caused by too great convexity of the cornea or lens, and is most common in early and middle life; the rays from a near object meet in their focus on the retina, and produce a distinct image; but the rays from a distant object, being nearly parallel, are more easily brought to a focus, and, therefore, meet before the retina, and only form undefined spectra upon it. This defect is partly corrected by means of a concave glass of suitable curvature; this causes the rays to become more divergent; therefore, they converge less quickly, and form their focus upon the retina. Presbyopia, or far-sightedness, is more common in old age, when the cornea and lens are less convex than in youth; the rays from distant objects, being nearly parallel, are refracted to a proper focus upon the retina; but those from near objects are not refracted soon enough, and, therefore, their focus is formed behind the retina, and do not form the image upon the nerve. This defect is remedied by a convex glass, which will cause the convergence of the rays from a near object, and bring them more rapidly to a focus, so as to form the image upon the retina, instead of behind it.—(For more full information on the function of vision, read Roget's Anim. and Veg. Phys., vol. ii., pp. 44–507; and an excellent chapter in Muller's Phys., trans. by Baly, vol. ii. pp. 1088–1214.)

SECTION VI.

ANATOMY OF THE EAR, OR ORGAN OF HEARING.

By the sense of hearing an animal is enabled to take cognizance of sounds, and of all their varieties. Sound is the result of any impulse conveyed by the undulations of the air to the organs of hearing, and the latter are so constructed as to receive these undulations, and so organized as to become sensible to them, and to convey the impressions to the sensorium. This sense, next to vision, is most valuable to man, as forming the bond of social union, and the great inlet for all knowledge conveyed by voice and language. Each organ, like the eye, consists, first and essentially, of a special nerve, expanded on membranes and endowed with the properties of sensibility to the impression of sounds, varying as they do in strength, quality, and tone, and of con-

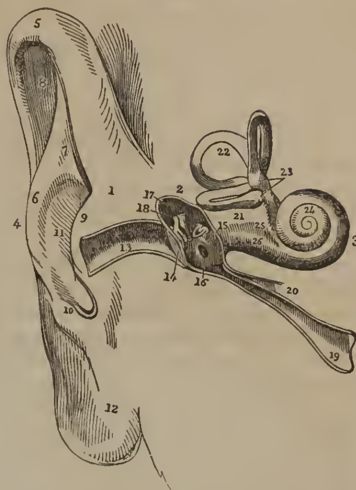
veying these impressions to the sensorium, or seat of perception; and, secondly, of a physical apparatus, fitted for receiving and conducting, and in some degree regulating, these impulses in their course to the sentient nerve. In the study of this organ the student should refer to the dry skull, and notice the form and course of the meatus externus and internus, and the other foramina in the temporal bone (*see* Osseous System). He may also refer to dry sections of the petrous bone exhibiting the semicircular canals, cochlea, vestibule, and tympanum; models and plates will also be of considerable assistance in explaining this complicated apparatus. All these parts should also be examined in the recent state, the most important characters of which can be exposed without much difficulty by the experienced dissector. Thus the tympanum can be easily opened from the inside of the cranium by chiselling out or cutting through, with a short, strong knife, that portion of bone between the squamous and petrous divisions of the temporal. The membrana tympani may then be seen; also the ossicula auditus, *in situ*, their muscles and ligaments, the corda tympani and tympanic plexus of nerves, and the several openings leading into and from this chamber. Next, by carefully dividing, partly with the saw and partly breaking with a chisel or light hammer, the petrous bone, in the line of the meatus auditorius internus, the vestibule may be opened, and the several openings into it from the semicircular canals, tympanum, and cochlea, seen; and the fibrillæ of the auditory nerve may also be traced through the cribriform plate to the different membranes in the labyrinth. The semicircular canals are best studied in preparations, but they can be also well seen by cutting and breaking the bone behind the internal meatus, as the cochlea can be similarly exposed in front; of course these remarks will not apply when we wish to make and preserve neat preparations of these parts. The canals and the vestibule may be easily exposed, and are beautiful objects for examination in the ear of any large fish; and in the cartilaginous species very little dissection is necessary to uncover them.

We may divide the ear into an external, middle and internal portion. The external comprises the auricle, commonly called ear, and the external meatus or tube; the middle consists of the tympanum or drum, with the ossicula auditus; and the internal, or true ear, is termed the labyrinth, and comprises the vestibule, cochlea, semicircular canals, meatus auditorius internus, and auditory nerves. This portion is lodged in the petrous division of the temporal bone, so remarkable for its hardness, whereby this organ is effectually protected from external pressure or injury.

The External Ear, or Auricle, is situated at the side of the head, behind the temporo-maxillary articulation, and in front of the mastoid process; it consists of the auricle or pinna and the external meatus, which terminates at and is closed by the membrana tympani.

Pinna, or *auricle*, commonly called the ear, is the external figured portion composed of cartilage, ligament, and a few muscular fibres; the whole inclosed in a duplicature of the skin; the general surface is convex towards the head and concave outwardly, in which aspect it presents several irregularities, such as eminences, grooves, and depressions, the latter all tending inwards and downwards towards the meatus, in which they end in a funnel-like manner. The convex border, which forms its outline, is named *helix* (ἑλιξ *plica*, or ἑιλω, *verto*). Superiorly this edge is thin, and curled outwards, so as to bound a depression, named *fossa innominata*; anteriorly it bends downwards and backwards, into the concha, and above the meatus. Anterior and inferior to the helix is the semicircular prominence, called *antihelix*. This is narrow below, but very prominent, and covered by very thin integument: as it ascends it becomes broader, retires from the surface and divides into two crura, which run in beneath the projecting hem-like border of the helix: the de-

Fig. 74.*



pression between its crura is named *scaphoid*, or *navicular fossa*. Anterior to and overhanging the meatus auditorius, somewhat like a valve, is the eminence called *tragus*, of a triangular form. The base is anteriorly behind the maxillary articulation; the apex is free, and directed a little backwards and outwards towards the concha; its inner surface is set with strong coarse hairs, or vibrissæ, which extend across the orifice of the meatus, and partly defend it against the entrance of foreign bodies. From these hairs it has derived its name, τραγος, *a goat*. When pressed backwards or inwards it can cover and close the meatus. Opposite to the tragus, and separated from it by a deep, round notch, is the *antitragus*, a small tubercle connected to the lower extremity of the antihelix. Within the antihelix, tragus, and antitragus, and traversed anteriorly and horizontally by the upper and anterior extremity of the helix, is the large, deep depression called *concha*, into which all the other grooves converge; it is of a funnel form, and leads obliquely downwards and forwards into the meatus auditorius. The lower pendulous part of the auricle is named the *lobe*, or lobulus, and is only composed of the soft fold of integument containing cellular and adipose tissue; it possesses but little organization, and has been selected in many countries as a favorable part to perforate, and from which to suspend ornaments of various kinds. The cartilage of the auricle constitutes its skeleton, and, being elastic, preserves its figure. When the integument is removed, it presents eminences and depressions nearly corresponding to those already described. No part of it enters into the lobe; it is covered by perichondrium, from which it derives considerable strength. If the latter be removed, the cartilage becomes brittle and weak. The portion of it forming the helix commences narrow in the concha above the meatus; it ascends and becomes broader, then turns round the top of the auricle, descends, decreases in breadth, and ends in a narrow, caudate point, separated from the antitragus by a fissure. Of the crura of the antihelix, the lower is very prominent, and runs inferiorly into the extremity of the helix. The cartilaginous plate of the tragus is connected to that of the helix only by fibrous tissue: it presents a deep fissure: the plate of the antitragus is continuous with that of the concha.

The *ligaments of the auricle* are, first, the *anterior*, which extends from the

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* The organ of hearing. 1. The external ear, including the cartilages and meatus externus. 2. The middle ear, consisting of the tympanum and its appendages. 3. The internal ear, or the labyrinth. 4. The pinna. 5. The helix. 6. The antihelix. 7. The fossa navicularis. 8. The fossa innominata. 9. The tragus. 10. The antitragus. 11. The concha. 12. The lobulus. 13. The meatus auditorius externus. 14. The membrana tympani. 15. The promontory. 16. The foramen rotundum. 17. The posterior wall of the tympanum, in which is an opening leading to the mastoid cells. 18. The ossicula auditus; four small bones within the cavity of the tympanum, namely, the malleus, incus, os orbiculare, and the stapes. 19. The Eustachian tube. 20. A narrow canal containing the tensor tympani muscle. 21. The vestibule. 22. The three semicircular canals, viz., the superior, posterior, and horizontal. 23. The ampullæ, at the termination of the superior and horizontal canals. 24. The cochlea. 25. The prominence caused by the scala vestibuli. 26. That of the scala tympani.

root of the zygoma to the anterior part of the helix and to the tragus; second, the *posterior*, which extends from the mastoid process to the concha, where it joins the meatus externus. Some writers also enumerate, as distinct ligaments, bands of fibres which pass from one cartilaginous eminence to another.

The *muscles of the external ear*, are divided into those which attach it to and move it upon the head, and those which only pass from one part of the cartilage to another. The former are three in number, viz., the anterior or attrahens, the superior or attollens, and the posterior or retrahens (*see* page 22). The latter, or the intrinsic muscles, are named from the eminences to which they are attached. First, the *major helicis* extends from the lower and anterior part of the helix to its superior free border. The *minor helicis* is inferior and posterior to the last; extends from the commencement of the transverse part of the helix, in the concha, to the posterior border of its ascending curved portion. The *tragicus* covers the cartilage of the tragus, extending from above its base to its apex. The *antitragicus* extends from the antitragus to the lower end of the antihelix. The *transversus auriculæ* consists of a few indistinct fasciculi, extending from the dorsum of the concha to the back of the antihelix. All these intrinsic muscles are feeble, and scarcely to be distinguished in man, and cannot exert any material influence: they may be considered as merely rudimental of those more highly developed muscles found in the large ears of most quadrupeds, which are enabled to alter the form and direction of the auricle and of its various curvatures with considerable force.

Meatus auditorius externus leads from the anterior and inferior part of the concha obliquely inwards to the membrana tympani; it is about an inch or an inch and a quarter long, is placed between the mastoid process and the maxillary articulation, and above and behind the parotid gland, which is closely moulded around one-half of its circumference. The external half of this tube is formed of cartilage, the remainder of bone, (*see* Temporal Bone, Osseous System); its direction is curved or tortuous, as will best appear from a mould taken of the entire tube, or from a horizonal section of it. It first leads forwards and upwards, then a little backwards, and, lastly, its osseous portion leads downwards, forwards, and inwards. By drawing the auricle upwards and backwards we can partly straighten the canal; and with a strong light directed into it we can see down to the membrana tympani. Its general curvature is convex upwards and concave downwards; and, from the obliquity of the membrana tympani, its lower wall is longer than the upper. A vertical section of the tube is of an oval form, the long axis being in that direction; it is dilated at its tympanic end, particularly on its inferior wall, and the narrowest parts of the tube are its commencement and its centre, where the cartilaginous and osseous portions join. The former can be separated by dissection from the latter, and is rather fibrous at the line of junction. This cartilage is not prone to the ossific change: it is somewhat of a triangular form, but curved so as to form about two-thirds of a cylinder. The base is below and behind, attached to the mastoid process; the apex is before, connected to the base of the tragus near the root of the zygoma; one side is attached to the anterior and lower border of the osseous tube by fibrous tissue, and the other is connected to and continuous with the base of the tragus; in fact, this portion of the tube appears as a continuation of the tragus. The superior and posterior part of the canal is formed by dense fibro-cellular tissue, which extends from the margin of the concha to the upper and posterior part of the osseous canal. Two or three fissures exist in the forepart of this cartilaginous meatus (incisuræ Santorini); their direction is transverse or oblique, and they are closed by dense fibrous tissue, in which Santorinus has described muscular fibres, which he supposed capable of shortening and con-

tracting the tube. The parotid, much cellular tissue, and sometimes a lymphatic gland, are in contact with this portion of the meatus, and small nerves and vessels enter it through the fissures: through one of these, also, deep-seated abscesses in this region sometimes open, and the matter may continue to discharge for a long time through the external meatus. The *bony portion* of the meatus is wanting in the child; a mere tympanic ring supplies its place; hence the meatus is much shorter at that age, and the membrana tympani can be more easily seen, and is more exposed to injury or accident. From this ring an osseous lamina gradually arises, and which for some years continues distinct from the temporal bone; as it increases it forms a sort of sheath for the styloid process, and continues separated from the anterior part of the glenoid cavity by the fissure of Glaser. This lamina also increases within or beneath the tympanic ring; and, therefore, in the full grown bone it forms not only the bony meatus, but also a portion of the lower wall of the tympanum. In the old subject there is frequently a foramen in this bony portion of the meatus. The external orifice of the meatus is of an oval form, but very variable in size: in old persons it is often set round with coarse hairs: the tragus partly covers and protects it. The internal or tympanic extremity of the tube is nearly circular, and directed obliquely downwards and inwards. The auditory canal is lined by the integument continued from the auricle and concha; it becomes extremely fine, vascular, and sensitive, and is covered by fine hairs. The cutis ceases at the margin of the lower extremity; but the cuticle is continued over the membrana tympani, from which it readily separates by maceration or putrefaction, and can then be drawn out of the meatus like a thimble or *cul de sac.* The skin, from a little distance within the external orifice to within a quarter of an inch of the tympanum, is perforated by numerous small openings, the orifices of the sebaceous follicles, and of the *cerumenous glands.* The latter are most numerous about the centre, or the constricted portion of the tube, that is, where the cartilaginous and osseous portions meet. These glands are small, oval bodies, of a pale yellowish color, and highly vascular; each consists of a convoluted cæcal tube, one extremity opening on the skin. These glands secrete the *cerumen,* or ear-wax, a yellow-brown, viscid substance, of an intensely bitter taste and slightly aromatic odor. When first secreted it is thin, yellowish, and milky, but soon concretes and hardens; it defends the passage from the entrance of foreign bodies, and may also serve to diminish the force of the undulations or vibrations of the air in their course to the membrana tympani.

SECTION VII.

MIDDLE EAR, OR TYMPANUM.

The tympanum is the space within the membrana tympani, and external to the osseous parietes of the vestibule and labyrinth, in front of the mastoid cells, and communicating anteriorly with the Eustachian tube. It is of a very irregular form, and presents a rugged, uneven surface; is bounded externally by the membrana tympani, and on all other sides by the petrous bone. It contains air and a little fluid; is traversed by the chain of small auricular bones and by fine nerves and vessels. Its perpendicular and antero-posterior diameters are nearly equal, and about half an inch in extent, or somewhat less; its transverse diameter, that is a line leading from the membrana tympani inwards to the vestibule, is only a quarter of an inch, or rather less. The walls of the cavity are lined by a fine mucous membrane, continuous through

the Eustachian tube with that of the nose and pharynx. This membrane is also reflected around the different parts which are contained in the cavity. We shall first examine the membrana tympani, which, with the bone to which it is attached, forms the outer side or wall of the tympanum, and separates it from the meatus externus.

Membrana tympani is situated at the inner and lower extremity of the meatus, separating it from the cavity of the tympanum or drum, the outer wall of which it forms; it is a thin, dry, semi-transparent membrane, nearly circular, the vertical diameter a little longer than the transverse or antero-posterior. In the infant it is more round; in the adult rather oval: it presents in the dead body an irregularly concave surface towards the meatus, and a convex one towards the tympanum. It is covered by the cuticle, continued from the parietes of the meatus, beneath which the proper fibrous tissue is inserted into the circular osseous groove which separates the meatus from the tympanum. This groove is placed obliquely, the lower part of its circumference being more internal or mesial than the superior; consequently the outer or concave surface of the membrane has an oblique aspect downwards and outwards, and forms an angle of 45° with the lower wall of the meatus, which latter, therefore, is longer than the superior. The inner surface of the membrana is directed upwards and inwards, adheres intimately to the handle of the malleus bone, and is lined by the mucous membrane continued from the pharynx through the Eustachian tube to line the drum. This attachment of the process of the malleus occupies more than the upper half of the vertical diameter of the membrane; and as this process is directed obliquely inwards, even to its very point, it appears to draw the membrane partially inwards, so as to present a funnel-formed cavity towards the meatus. In dry preparations this is uniformly the appearance of these parts; but when examined in the recent state, or during life, with the assistance of the "speculum auris," this form is not so distinct: the manubrium of the malleus rather makes a slight projection above the centre of the membrane, and is convex towards the meatus, while the general surface is unequally concave. From a mould taken of this surface in the recent state, I have observed very plainly this uneven appearance, and would infer that the general surface is concave towards the meatus, with a slight prominence leading from above the centre upwards to its superor margin. As, however, the membrane is vibratile, and yields to slight impressions, it is by no means improbable that after death it becomes more depressed, and, therefore, more convex towards the drum and concave towards the meatus, than it was during life. I recommend the student to make the following examination of this part, which can be done with little difficulty or trouble. Procure the head of a fœtus or infant; make a vertical section of the cranium and face; remove all unnecessary parts; dissect off the auricle and external meatus on a level with the tympanic ring; wash off the cuticular lining, and the membrana tympani will be fully and distinctly exposed. At this age it is larger in proportion than in the adult, and its aspect is almost directly downwards. Its central depression or concavity is deeply marked; and a little above this the manubrium of the malleus is distinctly prominent and convex, and its upper portion so thinly covered as to appear to be partially external to the fibrous lamina of the membrana. Its direction also, in respect to the membrane, is nearly vertical, but inclines a very little backwards; that is, when the head is turned in such a manner as to bring the parts fully into view; but if it be held in its proper position, with the zygoma horizontal, then, in consequence of the downward aspect of the membrane, the manubrium will be found to pass nearly in a horizontal line from the upper and outer border of the tympanic ring inwards towards the mesial line, and a little downwards to the centre of the membrana. I believe an erroneous idea generally prevails as to the direction of this bony process,

in consequence of the habit of regarding it in dry preparations, and especially in models, in which latter I have not yet seen it properly represented. In the adult, however, the manubrium is somewhat more vertical than in the fœtus, as in the former the membrane does not look so directly downwards as in the latter, the aspect being gradually altered from the horizontal to the oblique by the remarkable change of growth which occurs in the lower part of the tympanum and in the meatus externus. Next introduce a blowpipe into the Eustachian tube, and gently inflate the tympanum; the mobility and elasticity of the membrana are then beautifully seen, while its transparency admits of your observing through it the corda tympani, and the long crus of the incus, parallel but posterior to the manubrium of the malleus. At each distension of the cavity the membrane bulges outwards, not uniformly, but at either side of the manubrium and in the superior half. Very little change occurs in the central depression, or in the lower half, beyond a general vibration; and no force can swell out the membrane into one general convexity, or even into a plane surface, but the slightest distension causes a swell superiorly at each side of the manubrium. When the tympanum is thus distended, the fibres of the membrana are seen very distinctly running, in curved or arched lines, convex towards the meatus, towards the depressed centre, and towards the deeper surface of the manubrium. It appears to me that it is this fulness of these curved fibres, together with the prominence of the white manubrium and the strong illumination produced by the rays of light concentrated by the polished speculum, which have induced some to suppose that the membrana tympani is, during life, convex towards the surface, a condition which is the normal state in birds, there being in this class but one ossiculum auditus (columella or stapes), which supports the membrane, and retains it in that convex state, which is one of the striking anatomical peculiarities of the feathered race.

Mr. Wilde has made an examination of this membrane in the living ear, and has published the result of his researches in an excellent practical memoir in the Dub. Jour. of Med. Sci., vol. xxiv. No. 74, p. 421. He states: "The appearance of this membrane, when seen in life, by the speculum, is grayish, white, and semi-transparent; within it is seen the manubrium of the malleus, proceeding from above downwards and slightly forwards, about half way across the membrane, and dividing it into two portions, both of which are distinct from the purse-like projection of the fibro-mucous membrane behind the tubercle of the malleus, or 'membrana flaccida,' described by Shrapnell, which seems to me only rudimentary in man, but is well developed in some of the lower animals, the sheep in particular. The anterior and posterior divisions of the true membrane, as separated by the handle of the malleus, are of different curves and degrees of tension, and the whole membrane does not form a concavity on its external aspect, but its upper or anterior portion is flat or slightly concave, while that part below and behind the malleus is convex towards the external aperture. This lower portion is also more glistening than the upper or anterior, and, when viewed through the speculum, a bright spot of light shines upon its most convex portion, which is a little behind and below the point of the malleus. This peculiar curve I have again and again demonstrated to several members of the profession, and I believe the general external concavity ascribed to this membrane by anatomical writers is a *post mortem* appearance."

The *membrana tympani*, though thin and semi-transparent, consists of three distinct tissues, an external or epidermoid, already noticed, a middle or fibrous, and an internal or mucous. The middle or *fibrous lamina* is that on which the strength and form of this septum depend; to it the handle of the malleus is intimately attached. When carefully examined, either recent or dry, the fibres are very distinctly seen, pursuing a radiated arrangement and con-

verging from the circumference towards the centre, or rather towards the malleus, into the whole length of which they are inserted. Therefore, this portion of the membrane, which corresponds to the upper half of its vertical diameter, is the strongest: the circumference is also strengthened by a ligamentous ring attached to the bone. Some describe this membrane as consisting of two fibrous laminæ; the external one as composed of the radiating or converging fibres, the deeper layer being less evidently fibrous, and the fibres taking a different course from the superficial. No such accurate division, however, can be effected in the human membrane, although in the vicinity of the malleus, and towards the circumference, where the tissue is thicker, it may be partially separated into layers; the deeper stratum appears to be composed chiefly of vessels. The fibrous layer of the tympanum is stated by many writers to be muscular: this opinion has been corroborated by the assertion of Sir. E. Home, that in the elephant the muscular structure is very distinct (Phil. Trans. An. 1823). From recent examination of it in this animal, I do not feel disposed to concur in this statement, as the fibres appear white, tense, and shining, like those of true white fibrous tissue. A small, oblique, valvular opening (hiatus Rivini) has been described as existing in this membrane between its circumference and the manubrium of the malleus; most probably, however, this is an abnormal appearance, and only observed in some few cases, as a very careful examination of this part in the recent state does not disclose it. The membrane, also, is almost uniformly impervious to air; and when removed from the body I find it will retain water or quicksilver when placed on either surface. In the elephant, near the point of the malleus, there is an appearance of a small, oblique slit, in consequence of the elevation of the lining membrane by that bone, but it is closed towards the meatus. The vessels of the membrana admit of injection in the fœtus, either from the arteries or veins, and present a very beautiful, delicate, and radiated arrangement. It is most probable that they belong to the lining mucous membrane, rather than to the proper fibrous tissue. The membrana tympani serves to close the lower extremity of the external meatus, and to separate it from the tympanum, and is thus interposed between the external air and that which fills this cavity. It transmits the vibrations it sustains from the external impulses or undulations of the air to the chain of bones and to the air and fluid within the tympanum, through which these are carried to the internal or sentient part of the organ. The membrane also admits of relaxation and tension, which changes are effected by the motions of the small bones in the tympanum, to which we shall allude when we have examined the other parietes of the cavity.

The *tympanum* may be opened either by cutting away the upper or lower part of the petrous bone opposite the cavity, or by removing the membrane just described, which forms the outer part of this chamber. This cavity is a small space, of a very irregular form, about a quarter of an inch in extent from back to front, and less than the third of an inch from without inwards. It is bounded externally by the membrana tympani; internally by the petrous bone, which contains the labyrinth or the essential part of the organ, and which is separated from it by the membrana vestibuli, in the same manner as the tympanum is divided from the meatus by the membrana tympani. It is bounded behind by the mastoid portion of the temporal bone, containing cells with which it communicates. Anteriorly it leads into the Eustachian tube; above and below it is closed by bone. Its internal or vestibular side presents several objects for observation. At its upper part is situated the oval or rather kidney-shaped foramen, *fenestra ovalis*, or *vestibuli*. This opening is directly opposite the membrana tympani; it is convex above, more straight below: its long axis is transverse, and inclined a little downwards and forwards. In the dry bone it leads into the vestibule, but in the recent

state it is closed by a membrane, composed, like the membrana tympani, of three laminæ, viz., the lining of the vestibule, the lining of the tympanum, and an intermediate fibrous tissue. The base of the stapes bone also closes this opening, and is fixed between the fibrous layer and the tympanic mucous lining. This foramen is placed in a fossa beneath the curved ridge, or the aqueduct of Fallopius, which contains the portio dura nerve. Below the foramen ovale is the bony projection of the *promontory*, which corresponds to the first turn of the cochlea, and on the surface of which are delicate grooves, diverging above, and converging below to a common canal, which opens upon the inferior surface of the petrous bone, between the foramen caroticum and lacerum posticum, and transmits the small nerve of Jacobson from the glosso-pharyngeal nerve. Behind the fenestra ovalis is the bony *pyramid*, the apex of which is directed forwards and outwards, and is perforated by a small canal which leads to some extent into this hollow process, which contains a small muscle called stapedius. Below and rather behind the promontory is the *foramen rotundum*, or *fenestra cochleæ*, which in the dry bone is open, but in the recent state is closed by a membrane of the same nature as that of the fenestra vestibuli. In front of the fenestra ovalis, and above its transverse axis, is the opening of the canal which contains the tensor tympani muscle, or internal muscle of the malleus. This canal leads forwards and towards the mesial line, and is immediately above the Eustachian tube, separated from it by a thin, concave, osseous plate, named cochleariform process.

The upper wall of the tympanum is spongy or porous; a number of small vessels pass through it to the dura mater, which adheres closely to this part of the bone; a fact of some practical importance in case of suppuration within the tympanum, or of caries of the temporal bone. On this surface is a pit, or depression, for the head of the malleus and for the top and short leg of the incus.

The inferior wall of the tympanum is rough and narrow, and formed by the continuation of the external auditory plate and vaginal process.

The posterior wall presents at its upper part a large, irregular opening, which, both in the dry bone and in the recent state, leads into the mastoid cells. There is first one large cell, and this leads into an irregular series of others, which occupy the mastoid process; they are lined by mucous membrane, and are filled with air, analogous to the frontal and other sinuses which communicate with the nose. These cells do not exist in the fœtus; a depression, however, corresponds to the place of their future development. Below the mastoid opening is the small orifice from the aqueduct of Fallopius, close to the posterior part of the circumference of the membrana tympani, for the passage of the chorda tympani nerve.

The anterior wall of the tympanum tapers off into the Eustachian tube, above which are the cochleariform osseous plate and the canal for the tensor tympani muscle. This canal, as it leads backwards into the tympanum, is situated on its inner wall, and terminates in an opening, which is directed outwards or towards the membrana tympani. Cruveilhier not unaptly compares these two canals, one above the other, to a double-barrelled gun.

The *Eustachian tube* is a narrow canal, about an inch and a half long, leading from the tympanum obliquely forwards, downwards, and inwards towards the back of the nose, where it opens on the side of the pharynx, and on a level with the inferior spongy bone, behind and above the lower meatus of the nose, and above the velum and the tonsil. Its tympanic orifice is small compared to its nasal, which is large, trumpet-like, oval, and dilatable; it is composed of osseous, cartilaginous, fibrous, and mucous tissues. The first or tympanic portion is chiefly osseous, and is situated in the angle between the petrous and squamous bones; the remainder of the canal is bounded above by the groove between the petrous bone and the spinous

portion of the sphenoid; to this groove the sides or walls of the tube are attached. The outer wall is composed posteriorly of cartilage, and anteriorly of fibrous membrane, which is partly covered by the tensor palati muscle; the inner side, and in part the upper surface, is formed by a curved cartilaginous plate, which is attached to the petrous bone and to the root of the internal pterygoid process, and which becomes thick anteriorly towards the guttural orifice, where, when dissected, it appears divided into two angles, the anterior attached by the fibrous tissue to the root of the internal pterygoid plate; the posterior is thick, semilunar, and prominent, with its convexity upwards and backwards, and admitting of motion in that direction. The narrowest part of the tube is where the osseous and fibro-cartilaginous portions meet. The mucous membrane which lines it is very fine and delicate, excepting near the anterior orifice, where it acquires all the characters of that of the fauces. This orifice presents a large oval figure, with prominent edges directed obliquely downwards, forwards, and inwards. The *use* of this tube is to admit the external air into the tympanum, whereby the membrana tympani is enabled to support the external atmosphere, and can vibrate freely between the cavity and the meatus. The temperature of the air also within the tympanum is raised to a certain degree, which could not have been the case had it entered directly from the external meatus. It also conducts the secretions from the cavity of the tympanum and from its own walls downwards into the fauces.

The tympanum also presents another small opening or canal, anteriorly and inferiorly, which leads to the inner side of the fissure of Glasser, and transmits the corda tympani. The course of this nerve through the cavity may now be observed; it enters the tympanum at its posterior part, close to the circumference of the membrana tympani, and nearly on a level with its transverse diameter; it then passes in a curved manner forwards and downwards, convex upwards, between the handle of the malleus and the long leg of the incus, and escapes through the foramen and canal at the lower and anterior part of the tympanum, already described. The cavity of the tympanum is traversed by a chain of small bones, one of which is attached externally to the membrana tympani, and another to the membrana fenestræ vestibuli, whereby the impulse impressed upon the former is conveyed to the latter. We shall next examine these bones, with their ligaments and muscles.

Ossicula auditus are three, or, according to some, four in number, and are named, from their fancied resemblance to other bodies, *malleus* or hammer, *incus* or anvil, *stapes* or stirrup. The fourth, or *orbicular*, is by many considered as a mere epiphysis to the long leg of the incus. All these bones are very hard, and are very early developed in the fœtus.

Malleus is immediately within the membrana tympani, and connected to it; it presents a head, neck, handle, and long and short process. The *head* is in the recess in the upper part of the tympanum, above the membrana, and in front of the incus; it is smooth and round above, but concave below, or somewhat saddle-shaped for articulation with the incus. Below the head is the flattened *neck*, from which arise two processes; one is the *external* or *short*, and directed outwards to the upper part of the membrana tympani, which it supports; the other is the *gracilis*, or process of Rau, a delicate spine, about half an inch long, arising from the anterior part of the neck, ends in a broad, flat extremity, which rests in the Glasserian fissure, and gives attachment to a fibrous cord, by some described as a muscle under the name of laxator tympani; it is most probably, however, only a ligament. The *manubrium*, or handle, descends from the neck nearly vertical, or a little inwards; is at first compressed from the side corresponding to the articular surface, adheres intimately to the radiating fibres of the membrana tympani, becomes very slender, and descends as ow as the centre of that mem-

brane, where it ends in a flat or blunt extremity, a little curved, concave outwards.

Incus is placed internal and posterior to the malleus, and bears some resemblance to a bicuspid tooth; it presents a body or head, and a short and long crus. The *body* is directed upwards and forwards, is lodged in the recess of the tympanum, and receives the head of the malleus in its deep concave surface. The *short* or superior *crus* is thick and conical, and directed horizontally backwards in the recess in the tympanum, and occupies the opening into the mastoid cells. The long or inferior crus descends vertically in the tympanum, nearly parallel to the handle of the malleus, but on a plane internal and posterior to it, and separated from it by the chorda tympani; its lower end is bent inwards, like a hook, and is convex outwards. At its extremity is the round tubercle, which is sometimes united to it like an epiphysis, but is sometimes separable from it, and is named os orbiculare, or lenticulare.

The *stapes*, or stirrup, is placed horizontally between the crus of the incus or orbicular bone and the fenestra ovalis, to the membrane of which its base is attached. Its *head* presents a small cavity for articulation with the orbicular bone, or with the crus of the incus; its *base* is a thin plate, closing the fenestra ovalis. Of its two *crura*, the posterior is the longer and more curved.

The articulations between these bones are furnished with synovial membranes and capsular ligaments, and are further secured in their position, by *three ligaments*. One extends from the head of the malleus to the upper wall of the tympanum; another connects the short process of the incus to the opening of the mastoid cells; and a third extends from the margin of the fenestra ovalis to the margin of the base of the stapes. A fourth might be added, extending from the process of Rau through the Glasserian fissure.

The muscles of the tympanum are only two in number, the stapedius and the tensor tympani.

Stapedius muscle *arises* within the pyramid, escapes from its point by a small tendon which passes forwards, downwards, and a little outwards, and is *inserted* in the back part of the neck of the stapes. Its action must be to press the back part of the base of the stapes against the fenestra; at the same time it draws inwards the crus of the incus, and rotates the malleus so as to draw inwards the manubrium, and thereby make tense the membrana tympani: it must also serve to fix the stapes, and retain it *in situ*. Some consider it as a mere ligament between the stapes and the petrous bone, as it resembles a white fibrous cord rather than a muscle. I may observe that in the elephant it is well developed, and there can be no doubt of its being a true muscle.

Tensor tympani, or internal muscle of the malleus, is a very distinct and long fibro-muscular cord, chiefly lodged in the bony canal already described, above the cochleariform process and the Eustachian tube, to which it is parallel in the greater part of its course. It *arises* from the cartilage of that tube and from the adjacent portion of the sphenoid bone, behind its spinous foramen; also from the sides of the bony canal, in which it is inclosed. The fleshy fibres proceed backwards, and end in a tendon which enters the forepart of the tympanum, and is then reflected at a right angle outwards, like the canal in which it is inclosed, and is *inserted* into the inner, anterior, and superior portion of the handle of the malleus, below the processus gracilis, and opposite the root of the short process. *Use.*—To draw the handle of the malleus inwards and forwards, whereby the membrana tympani, is drawn inwards and made more tense. In this motion the processus gracilis may be considered as an axis on which the whole malleolus moves, the head being directed backwards and outwards, and the manubrium inwards and forwards. The incus being connected with the head of the malleus, and moving on its short crus, as on an axis, follows the malleus outwards, while its long crus is directed inwards, and presses the stapes against the membrana vestibuli, and

renders it more tense; this latter effect being still further secured by the action of the stapedius muscle, as before described.

Two other muscles are described by some writers, but it is more than doubtful whether any such exist, ligamentous fibres being described as muscular; they have been named laxator tympani major, or anterior or external muscle of the malleus. and laxator tympani minor, or superior muscle of the malleus. The *laxator major* extends from the processus gracilis of the malleus through the glenoid fissure, and is continuous with the fibrous tissue of the spinous portion of the sphenoid bone and of the internal lateral ligament of the maxillary articulation. It possesses all the characters of a ligament, fixing the process of Rau in its situation, and when the latter is short an extension of this cord supplies its place. The *laxator minor* is nothing more than a fibrous cord descending from the upper part of the tympanic ring to the handle of the malleus, below the short process. As the membrana tympani can be made more tense by the two muscles first described, their relaxation must allow the membrane to fall into a corresponding state; there is, therefore, no apparent use or necessity for laxator muscles. This remark, together with the apparent ligamentous structure of the two last described cords, induce us to regard them as mere ligaments, and to consider the true muscles of the ossicula as only two in number, and as tensors of the membrana tympani and the membrana vestibuli.

The tympanum is lined by a fine membrane, which, being continuous through the Eustachian canal with that of the pharynx, belongs to the mucous class. In this cavity, however, it becomes extremely delicate, and, being intimately united to the periosteum, is properly a fibro-mucous membrane; it covers all the irregularities on the walls of the cavity; is reflected around the bones, muscles, and nerves which traverse it; lines the inner side of the membrana tympani, the outer side of the membrana vestibuli, closes the fenestra cochleæ, also the space between the crura of the stapes, and is continued into the mastoid cells. It is not prolonged into the labyrinth or internal ear, but forms a perfect septum between it and the tympanic cavity; its continuity through the Eustachian tube with the gastro-pulmonary surface is of practical moment.

SECTION VIII.

INTERNAL EAR, OR LABYRINTH.

This is the essential part of the organ of hearing: it lies deeply buried in the petrous bone, and consists of a number of curiously formed channels and spaces wrought out of the osseous structure, and containing delicate membraneous tubes filled with fluid; on these the terminal branches of the sentient nerve are expanded. The *labyrinth* consists of two portions, an osseous and a membraneous. The *osseous labyrinth* consists of three distinct compartments: one in the centre, named the vestibule; one behind this, composed of three semicircular canals; and one in front of it, named the cochlea. Both the anterior and posterior compartments communicate with the vestibule; and the meatus auditorious internus communicates with each of these by minute foramina for the transmission of the auditory nerves.

The *meatus internus* should be first examined; it is shorter and smaller than the external; is scarcely a quarter of an inch in length, and is a little wider at its cerebral than at its aural end; lined by the dura mater, it leads from the cranium directly outwards, and ends in a *cul de sac*, which is subdivided into two by a horizontal bony crest. The superior and smaller depression presents posteriorly some small foramina, which open on the inner

side of the vestibule, and transmit auditory filaments into that chamber; and anteriorly the large opening of the superior and internal extremity of the aqueduct of Fallopius for the passage of the facial nerve. The lower and longer depression corresponds anteriorly to the base of the cochlea, and presents a spiral canal answering to the turns of that tube, and is perforated by numerous apertures, of which one is larger than the others, and leads into a canal in the axis or modiolus of the cochlea. The posterior part of this *cul de sac* presents a superficial cribriform fossa, over the hemispherical depression of the vestibule. Through these various minute foramina, the fibrillæ of the mollis or auditory nerve, enter the labyrinth, and are expanded on the membranes within it.

The *vestibule*, or central cavity of the labyrinth, is a very small space placed between the fenestra ovalis and the meatus auditorius internus. Its diameter in this transverse direction is about the eighth of an inch, and its vertical and antero-posterior diameters are longer, or about the fifth part of an inch; its form is very irregular, being extended or dilated somewhat in three situations, namely, superiorly, and inferiorly both before and behind. These dilatations are called its *ventricles* or *cornua;* one is named superior cornu, another inferior and posterior, and the third inferior and anterior. In each of these cornu there are certain openings to be observed. The vestibule presents on all sides a number of foramina, some large and distinct, others very minute. On its external or tympanic wall is seen the fenestra ovalis, perfectly closed by membrane and by the base of the stapes; the transverse or long axis of this opening is about the tenth of an inch; its vertical is much less; its margin projects inwards towards the vestibule. The inner or cerebral wall of the vestibule corresponds to the bottom of the meatus auditorius internus, is cribriform (*macula cribrosa*), and transmits some fibrillæ of the auditory nerve and some fine capillary vessels. In the *posterior* and *lower horn* are seen three distinct foramina, the orifices of the semicircular canals. In the *superior cornu* are the other two openings of these tubes. In the *inferior* and *anterior cornu* is a distinct oval opening, which leads downwards and forwards into the vestibular scala of the cochlea. Thus the vestibule presents seven large foramina, viz., the fenestra ovalis, fenestra cochleæ, and the openings of five semicircular canals. In addition to these there are several smaller foramina, namely, first, those in the cribriform lamina for the auditory nerves; second, the *aqueductus vestibuli*, which opens in a sulcus on the posterior wall, internal to the common opening of the semicircular canals; this aqueduct first bends round this common opening, and then turns at a right angle downwards, and, descending through the petrous bone, opens upon its posterior surface, behind the meatus internus. It transmits a small vein, and its long membrane is continuous with the dura mater. In the anterior horn is a depression (*fovea hemisperica*), cribriform for the passage of nerves, and corresponding to the posterior division of the *cul de sac* of the meatus internus. This depression is separated from another smaller depression, also cribriform (*fovea elliptica*), by a prominent bony ridge (*eminentia pyramidalis*). The several eminences and depressions in this region have been described with an unnecessary degree of minuteness, not likely to lead to any physiological conclusions.

Semicircular canals are three bony tubes imbedded in the petrous bone, behind the vestibule, and communicating with it: they are curved so as to form nearly three-fourths of a circle; their calibre is not quite round, but they are compressed laterally, therefore a vertical section of any of them presents an elliptical orifice. They open by each extremity into the vestibule; but, as two of them unite by their adjoining extremities, they present only five openings in this chamber. Their diameter is about one-twentieth of an inch, but they are a little wider at their orifices, where one extremity of each is dilated

into a sort of sinus or ampulla, of which there are three. Of these canals two have a perpendicular and one an horizontal direction; they are distinguished by the names of superior or anterior vertical, inferior or posterior vertical or oblique, and the horizontal. The *superior vertical* is convex upwards, runs transversely across the petrous bone, and its projection is seen upon its upper surface. particularly in the fœtus. The outer extremity opens by an ampulla in the superior horn of the vestibule, and the inner joins the upper crus of the posterior vertical or oblique canal, and opens by a common orifice in the posterior horn of the ventricle. The *posterior vertical* or *oblique* is in and parallel to the posterior part of the petrous bone; is convex upwards and outwards; one extremity opens in the ampulla in the posterior horn, and the other in the common canal with the last. The *inferior or horizontal canal* is shorter than either of the vertical; is convex outwards; one end opens in the ampulla in the upper horn, the other in the posterior horn. The external extremity of the vertical, the inferior of the oblique, and the anterior of the horizontal, are the three ends of the canals which present ampullary dilatations.

The *cochlea* is the most anterior part of the labyrinth, and is a very complicated apparatus. It is resembled to the snail-shell; is situated in the anterior portion of the petrous bone on the inner side, and in front of the tympanum; is of a conical form; its apex is directed forwards, outwards, and downwards, and its base corresponds to the bottom of the meatus internus. We may suppose it to be a tapering tube, closed at its smaller extremity, coiled round a central pillar, and this tube subdivided by a partition into two semicylindrical tubes. It presents for our notice the tube, the lamina spiralis, the axis or modiolus, and the scalæ. The *tube* is about an inch and a half long and the tenth of an inch in diameter at its commencement, and one-twentieth at its termination. It describes two turns and a half, in a direction from below upwards and from without inwards; the second turn lies, at its beginning, within the first, but near its end rises above it. The *axis* or *modiolus* is a conical tube, whose summit is expanded like a funnel; *arises* from the base of the cochlea, opposite the bottom of the meatus internus; and is directed almost horizontally outwards: it occupies the centre of the cochlea, the coils of which and of the lamina spiralis twine around it. The whole of the axis is concealed by the tube of the cochlea; its base or origin is pierced with foramina for the auditory nerves; it becomes very thick opposite the first turn, and thinner afterwards. Its apex is expanded into a process named *infundibulum*, which is arched over and covered in by the blind apex of the tube or the cupola. This terminal portion is rather of a semifunnel form, the cavity turned towards the lower part of the cochlea. The modiolus does not appear to be a distinct structure, but rather the space circumscribed by the inner wall of the tube of the cochlea. Consequently, we find that it appears of a larger diameter in the space corresponding to the first turn of the cochlea, and that it diminishes in proportion as the coils of the cochlea become contracted; therefore, the diameter of the modiolus as it ascends within the second coil is much diminished. The infundibuliform expansion of the apex, which looks downwards and towards the apex of the cochlea or the cupola, is best seen by opening the cochlea from its under surface. The centre of the modiolus is traversed by a number of canals for branches of the auditory nerves and bloodvessels. These canals open by foramina on its surface, and correspond to fine canals on the lamina spiralis. One of these canals is larger than the rest, and is named the *tubulis centralis modioli*, and passes upwarus to the infundibulum.

The *lamina spiralis* is a very thin plate of bone, whose breadth is increased in the recent state by membrane; it is wound spirally, like the thread of a screw, round the modiolus, into which its inner margin is inserted. Its outer

margin in the dry bone is free, but in the recent state the membrane is continued from it to the outer wall of the tube, which it thus divides into two semicylindrical tubes, termed *scalæ*, and between which it forms a perfect partition. The breadth of the osseous portion of this lamina decreases as it ascends in the tube; and, if we suppose it unrolled from off the modiolus and extended, it would represent an isosceles triangle, the base below, the apex above. The latter, which is very narrow, stands out from the modiolus in the form of a hook (the *hamulus of the lamina spiralis*). This hamulus is attached to the inner surface of the apex of the cochlea; its inner or concave border is opposite the concavity of the infundibulum termination of the modiolus, is free and unattached to it, and thus leaves a circular opening, which communicates with the two scalæ. This will be more particularly noticed presently. The membraneous portion of this lamina which completes the septum is, on the contrary, broader above than below, and, if separated and unrolled, would also represent an isosceles triangle, with the base above corresponding to the apex of the former, and its apex below at the base of the osseous triangle. This lamina spiralis, both in its osseous and membraneous portions, is composed of two thin plates, between which the cochlear nerves and vessels are distributed.

The two secondary cavities, into which the cochlear tube is divided by the lamina spiralis, are called *scalæ*. One is superior and external, and is named the *vestibular scala*, because it directly communicates with the vestibule; the other is larger, is internal and inferior, and is named *scala tympani*, because it communicates with the tympanum through the fenestra rotunda. In the recent state, however, this communication is closed by membrane. A section of either of these scalæ, made at right angles to its axis, is of a semicircular form. Although these scalæ are separate through the entire of their extent, yet they communicate with each other near the summit of the cochlea, over the hamulus, by a small opening common to both, named by Breschet *helicotrema*. The manner in which this communication comes to exist is this. The osseous lamina spiralis is inserted by its concavity into the modiolus; but superiorly it parts from it, and its inner or concave edge stands out like a beak from the central axis. This beak or hamulus corresponds to the infundibulum, and thus the two concavities leave a space between them which is the helicotrema, and by means of which the two scalæ, though previously perfectly separated, communicate with each other.

Near the termination of the scala tympani, at the fenestra rotunda, is a small foramen, the opening of the *aqueduct of the cochlea;* the other end of which presents an expanded opening upon the lower border of the petrous bone, near the jugular fossa: it is merely a canal for a small vein.

The *membrane lining the labyrinthic cavity.*—This is not to be confounded with the membraneous labyrinth itself, from which it is not only perfectly distinct, but separated by a fluid. The lining membrane is extremely delicate, and of a fibro-serous character. One surface is closely adherent to the bone, and acts the part of an internal periosteum. The other or free surface is smooth, and secretes a semi-fluid, the *perilymph* or *aqua Cotunnii*. The foramen rotundum is closed by three membranes; externally by the mucous lining of the tympanum, a central proper membrane, and an internal reflection from the membrane under consideration, which is from thence continued into the scala tympani, from which it is prolonged, through the helicotrema, into the scala vestibuli, and so into the vestibule and semicircular canals. The lamina spiralis, by this arrangement, receives a covering from this fibro-serous membrane. One surface is covered by the membrane of the scala tympani, the other by that of the scala vestibuli. At the external free margin of the lamina spiralis these two membranes meet, and are extended to the outer wall of the tube, thus completing the partition between the two scalæ. The coch

lea is richly supplied with nerves, and the spiral lamina is the principal seat of their distribution. The nerves having escaped from the sides of the modiolus by the apertures already noticed, diverge between the bony plates and the two layers of membrane of which the spiral lamina is composed.

The *membraneous labyrinth* is not so extensive as the osseous labyrinth, as it does not enter the cochlea; it is also much smaller than that portion of the osseous labyrinth to which it corresponds, and from the walls of which it is separated by the perilymph. The membraneous labyrinth is itself filled by a fluid which might be termed the fluid of Scarpa; it is called the endolymph by Breschet. The membraneous labyrinth consists of, first, the common sinus; second, the sacculus; and, third, the membraneous semicircular canals.

First. The *common sinus,* or *vestibular ventricle,* is an elongated, laterally compressed pouch, which occupies the posterior part of the vestibule; the semicircular tubes are continuous with it, and open into it by five orifices; it floats in the liquor Cotunnii or perilymph, and is distended by the liquor Scarpæ or endolymph.

Second. The *sacculus vestibuli* is much smaller than the sinus; is round, and situated inferior and anterior to the sinus to which it adheres, but whether they communicate or not has not been determined.

Third. *Membraneous semicircular canals* have precisely the same form as the osseous tubes, and present the same number of ampullæ or ovoid vesicles. They are of course smaller than the bony canals within which they are contained, and from the walls of which they are separated by the perilymph; they are themselves distended by endolymph. A question has arisen as to whether there exists any thing in the human ear analogous to the solid calcareous concretions found in the internal ear of the osseous fishes, and which have been named *otolithi.* It would appear from the researches of Breschet that such are represented in the ear of man by a powder composed of carbonate and phosphate of lime, to which he has given the name of *otoconia.* This powder is collected into two masses observable on the sinus and saccule. Huschke describes the grains as crystalline, small, six-sided columns: others consider them as oval. W. Jones found that the greater number had their longest diameter equal to that of the globules of the human blood, or about 1-3000th of an inch. Breschet regards them as of service in communicating to the nervous expansion a more vivid and energetic impression than a simple liquid could effect. The development of these bodies bears a considerable relation to the medium which the animal inhabits, being solid and stony in the aquatic and pulverulent in the aerial.

As the visual apparatus is supplied with different nerves, possessed of different properties or endowments, so is the acoustic. The essential or the special nerve of sense is the portio mollis of the seventh pair. Sensibility to the whole organ, and motor power to the muscles of the ossicula auditus, and a sympathetic connection with the velum palati, with the nose and eye, and with the system generally, are imparted by the connection between the fifth pair, the sympathetic, the glosso-pharyngeal, and portio dura nerves; filaments from which form a delicate network in the tympanum, named the tympanic plexus; while the external ear and meatus are also partly supplied from the cervical plexus. These nerves have been already individually examined (*see* Nervous System); we shall here consider them collectively, and in reference only to this organ.

The *auditory nerve* has been named portio mollis from its softness. Having arisen in the manner already described (page 431), it enters the meatus auditorius internus, and, having arrived at the situation where this passage is interrupted by a bony septum, divides into two branches, an *anterior* larger branch for the cochlea, a *posterior* smaller for the vestibule and semicircular canals. Breschet states that the neurine filaments, in penetrating into the interior of the several membraneous pouches, are accompanied by a sheath fur-

nished by the pouch itself. The membrane is here folded inwards on the nerve, forming an internal projection or imperfect septum, more remarkable in the ampullæ than in the saccule or sinus. The nerves of the ampullæ then divide into numerous fine branches, which, forming a nervous membrane, covers the septum and adjacent wall of the ampullæ. In the case of the sinus and saccule, the nerve is first expanded in a fan-like form, and, having penetrated the membrane, resolves itself into a nervous layer like the retina, which lines these cavities.

The *vestibular nerve*, or the posterior division, immediately separates into three sets of fasciculi, superior, middle, and inferior. The superior pass through the minute foramina of the pyramidal eminence into the superior ventricle of the vestibule, and are expanded on the sacculus communis and on the ampullæ of the perpendicular and horizontal semicircular canals. The middle set pass through the macula cribrosa into the anterior ventricle, and expand on the sacculus proprius: and the posterior set pass through the posterior wall of the vestibule, and are lost in the ampullary dilatation of the oblique semicircular membraneous canal.

The *cochlear nerve* resembles a flat tape rolled on itself lengthways. It passes downwards to the depression at the bottom of the internal meatus, corresponding to the base of the axis; it here divides into a number of fine filaments, which enter the small bony canals leading from these foramina into the substance of the axis, and, bending nearly at right angles, pass between the osseous plates forming the lamina spiralis. The first filaments are the longest; they gradually diminish in length according as the spiral lamina upon which they are distributed contracts in breadth. The nerve divides into numerous minute branches, which anastomose with one another, and spread out into a delicate nervous membrane, or, according to Treviranus and Gittsche, terminate in the form of papillæ.—*See* Breschet's *Recherches Anat. and Physiol. sur l' Organe de l' Ouie.* Paris, 1836).

Bloodvessels of the labyrinth are derived principally from the arteria auditiva interna, a branch either of the basilar or of the superior cerebellar artery. Its presence is constant, but its precise origin uncertain. It enters the internal meatus along with the seventh pair, and divides into two branches, the cochlear and the vestibular; the former, passing into the modiolus, gives off one branch, the arteria centralis modioli, which passes through the central canal of the axis as far as the apex of the cochlea. The other branches pass through the spiral tract of holes, and radiating anastomose at the external margin of the osseous zone. From the loop thus formed more numerous branches arise, run parallel for a short distance, and, uniting, form the second anastomosing loop, from which capillary branches run, which ultimately terminate in a venous sinus lodged between the layers of the outer portion of the membraneous spiral lamina. The vestibular artery supplies the vestibule and semicircular canals; a few tubular branches are also very generally derived from the posterior auricular and occipital arteries.

The absorbents of the labyrinth have not been demonstrated; their existence is inferred from analogy.

The *facial* or *portio dura nerve* enters the meatus internus along with the auditory, and is said to communicate with it at the bottom of this canal (*see* page 441). I have lately seen this communication very distinctly in the elephant. From the superior depression in the meatus this nerve enters the aqueduct of Fallopius, which leads first forwards and outwards to the hiatus Fallopii, where it is joined by the superior petrosal branch of the Vidian, and presents a ganglionic enlargement. It then bends at an acute angle backwards and a little downwards to the tympanum, forming an eminence on its posterior wall, above the fenestra ovalis, and finally descends vertically to the stylo-mastoid foramen. In this course, therefore, through the aqueduct, it makes two bends or turns; one is abrupt and angular, and in a horizontal

plane, close to the superioi surface of the petrous bone, which covers it, but which can be easily removed. The second is a gradual and round turn from the upper to the inner and posterior wall of the tympanum. From its ganglionic swelling at the junction with the Vidian one or two delicate filaments pass backwards into the meatus towards the portio mollis.

The *chorda tympani* may be regarded either as proceeding from this ganglion, or as the continued petrosal nerve from the Vidian. It accompanies the portio dura nearly to the stylo-mastoid hole, then leaves it in an acute angle, ascends in a bony canal which opens into the tympanum by a small foramen behind the pyramid, and close to the tympanic ring; then passes forwards, invested by mucous membrane, between the handle of the malleus and long crus of the incus, across the tympanum, communicating with delicate filaments of the fifth nerve on the membrane, and escapes from the lower and anterior angle of the cavity by a fine bony canal by the side of the Glasserian fissure in the glenoid fossa. In the aqueduct the porta dura also sends off a fine filament to the stapedius muscle.

The *tympanic plexus* is a delicate network, described by Breschet and Arnold, and chiefly formed by the tympanic branch of the glosso-pharyngeal, named the nerve of Jacobson. This arises from the petrous ganglion of the glosso-pharyngeal, enters the tympanic canal, which opens on the lower surface of the petrous bone, between the carotid foramen and jugular fossa; it leads upwards into the tympanum, and opens into the groove on the promontory, and from the upper part of this groove, leads upwards and forwards between the tensor tympani muscle and the aqueduct of Fallopius, and opens on the upper surface of the petrous bone, anterior and external to the hiatus Fallopii. This nerve, shortly after its origin, is joined by a filament from the pneumogastric and from the superior cervical ganglion of the sympathetic. In the tympanum its filaments separate and reunite in the tympanic plexus. This sends branches to the membrana, the fenestra ovalis, and to the lining of the tympanum; also branches to the Eustachian tube, some of which pass out of this tube into the carotid canal, and communicate with the carotid plexus of nerves. The continued tympanic nerve then enters the superior part of the tympanic canal, escapes from it into the superior petrosal groove, and passes forwards between the petrous bone and spinous portion of the sphenoid. It is now named lesser superior petrosal nerve, and joins the Otic ganglion on the side of the inferior maxillary nerve. From this ganglion a small filament passes to the tensor tympani muscle.

From a review of the complex structure of the ear we may infer the uses of the several parts. The auricle collects and concentrates the sounds which fall upon it; and, by the motions of the head and spine, it can be turned in every direction to receive them. In animals this is chiefly effected by the muscles which move this part. The meatus externus conducts and reflects from its sides the sonorous undulations to the membrana tympani, which is thereby thrown into vibrations, and these are transmitted by the chain of bones to the membrana vestibuli, and partly to that of the foramen rotundum, through the air and fluid which the tympanum contains. The Eustachian tube, by admitting air into this chamber, favors these vibrations, as well as the motions of the ossicula: it may also allow the escape of such sonorous impulses as strike on the walls of the labyrinth, and which might produce an echo or confusion of sound. The mastoid cells may also contribute to this effect, as well as lighten the bone. Finally, the impressions impinge on the membraneous labyrinth on which the sentient nerves are expanded, and these convey the impressions to the sensorium. Sonorous undulations, also, which strike the bones of the head and face, and the teeth, are transmitted through these solid structures to the temporal bone, especially to the cochlea, on which numerous auditory nerves are expanded.

PART IV.

ANATOMY OF THE OSSEOUS SYSTEM.

UNDER THIS HEAD WE MAY CONSIDER THE ANATOMY OF THE BONES, LIGAMENTS, AND JOINTS.

CHAPTER I.

DESCRIPTION OF THE BONES.

SECTION I.

GENERAL OBSERVATIONS ON THE OSSEOUS SYSTEM.

THE osseous structure is the hardest in the body; it is composed chiefly of phosphate of lime, with a little carbonate deposited in a cartilaginous substance, which is perfectly organized, and well supplied with bloodvessels for its nourishment and growth.

The bones present great variety of figure, and are commonly classed into the *flat*, *long*, and *irregular*. They support and protect the softer tissues, give the general form to the whole body, as well as to its different parts; and they also serve as the passive organs of locomotion, affording a series of levers by means of which the muscles effect the various motions and actions of the body.

When all the bones are connected by their ligaments, the collection is called a *natural skeleton;* when united by art, an *artificial skeleton.* The skeleton is divided into the trunk and extremities.

The *trunk* consists of the middle part and two extremities. The middle of the trunk is formed by the vertebral column and the thorax. At the upper extremity of the trunk is the head, at the lower the pelvis.

The *vertebral column* consists of twenty-four vertebræ, which are divided into three classes according to the three regions, viz., seven cervical, twelve dorsal, and five lumbar.

The *thorax* or *chest* is formed before by the sternum, which in the adult consists of two pieces, with the xiphoid appendix; on either side by the twelve ribs; and behind by the dorsal vertebræ.

The *head* comprises the cranium and the face. The *cranium* or *skull* is composed of eight, or, according to some, of eighteen bones, viz., the frontal, the two temporal, the two parietal, the occipital, the ethmoid, and the sphenoid. To these may be added the ten following, viz., the two small turbinated bones of the sphenoid or of Bertin, and the four auricular bones in each tem·

poral bone, which latter have been already described in the anatomy of the ear.

The *face* is divided into the upper and lower jaw. The *upper* consists of thirteen bones, viz., the two superior maxillary, two palatine, two lachrymal, two nasal, two malar, two inferior turbinated bones, and the vomer. To these may be added the sixteen teeth. The *lower jaw* consists of the inferior maxillary bone, which contains sixteen teeth. Some consider the os hyoides as an appendix to the bones of the face: this bone, however, has been already noticed in the description of the larnyx.

The *pelvis* is the lower extremity of the trunk; it consists of the sacrum, the os coccygis, and the two ossa innominata.

The *superior* or *thoracic extremities* are composed each of four parts: the shoulder, which consists of two bones, the clavicle and scapula; the arm, of the humerus; the forearm of two, the radius and ulna; and the hand, which is subdivided into the carpus, metacarpus, and fingers. The carpus consists of eight small bones, the metacarpus of five, and the fingers of fourteen, each consisting of three phalanges, except the thumb, which has only two.

The *inferior* or *abdominal extremities* are each divided into three parts: the thigh, which consists of but one bone, the femur; the leg, which consists of three, the patella, tibia, and fibula; and the foot, which is divided into three parts, the tarsus, metatarsus, and toes. The tarsus consists of seven irregular bones, the metatarsus of five long bones, and the toes of fourteen, each consisting of three phalanges, except the great toe, which has only two.

In the adult skeleton, therefore, the number of essential bones amounts to two hundred, namely: eight in the cranium, fourteen in the face, twenty-four in the spine, twenty-six in the thorax, four in the pelvis, sixty-four in the upper extremities, and sixty in the lower. If to these we add the two bones of Bertin, the eight ossicula auditus, and the thirty-two teeth, the total will be two hundred and forty-two, excluding, of course, the os hyoides and the sesamoid tubercles. This number is, however, variously stated by writers, some bones being separated into more parts by some authors than by others. Thus some consider the sternum as consisting of three pieces, and each os innominatum also of three; others, on the contrary, diminish this number by regarding the sternum as one, the sacrum and coccyx as one, also the occipital and sphenoid bones as one.

Although bone is the principal constituent of the human skeleton, yet cartilage is also extensively employed in some parts as auxiliary to, and in others as a substitute for it. In the earlier periods of embryonic life it is almost the sole agent in forming its outline, as true bone is not produced in the first instance; the skeleton, at that period, being like all other parts, made up of elementary cells connected together by a soft blastema. These cells soon become cartilaginous, and in this tissue ossification commences by many points, rapidly extends, and gradually imparts the stability and firmness necessary in the framework of the future being. Some parts also retain more or less of cartilage through life, and in some situations and organs it is permanently employed instead of true bone. In the cartilaginous fish the skeleton is wholly composed of it, and in many other animals also it is largely employed in its formation. As the human skeleton, then, is formed partly of bone and partly of cartilage, these two tissues must be intimately connected and co-operate in function; we shall, therefore, consider them together, although they differ from one another in many essential respects.

Cartilage is found in different situations in the animal body. In the first place it forms, in the young being, the greater portion of the skeleton, imparts to it sufficient firmness, and preserves its proper form, while it serves as the nidus for the deposition of bone. Such cartilage is termed *temporary*. Secondly, it covers the articular ends of the long and irregular bones, and

forms an important element in the joints. Such are named *incrusting cartilages;* they are also called *permanent.* In some situations these answer the office of bone, as the costal cartilages in the forepart of the thorax, and are even superior to it, on account of their elasticity. The parietes of the larynx, trachea, and bronchi, also the external auditory meatus, and the septum and alæ nasi, are formed of cartilage, which in these situations is thin and expanded, and has been named by some *membraniform cartilage.* Thirdly, in some situations the true cartilaginous tissue is intermingled with fibrous tissue, and is then named *fibro-cartilage;* this tissue is composed of fasciculi of white fibres, the interstices being filled with true cartilage cells, connected together by cellular tissue. These fibro-cartilages present great diversity in structure and consistence according as one or other element predominates; they are elastic, like cartilage, but stronger, and more tough and resisting; they are found in different situations, and answer different purposes; they contribute to form thecæ and trochleæ for tendons; they adhere circumferentially to the margins of some articulations, and thereby deepen their cavity. Such are named cotyloid, or glenoid. Others are *interarticular,* that is, not adhering to, but interposed between the ends of the bones in certain joints: others of this class adhere to the opposed surfaces, as in the sterno-clavicular articulation, the pubic symphisis, and between the bodies of the vertebræ. The Eustachian tubes, the external ears or auricles, the palpebræ, and the epiglottis, all belong to this tissue, and owe their consistence and elasticity to its presence. The epiglottis also possesses some yellow elastic tissue.

Cartilage, when examined in a mass, appears of a white or pearly hue, especially the articular and the temporary cartilages; but the permanent, the membraniform, and the fibro-cartilages, often present a yellowish tint; it is smooth, in many situations polished and glistening, and opaque, but, when divided into thin laminæ, is semi-transparent. It is a very dense and strong tissue, but admits of being cut with a sharp knife; it yields to pressure or torsion, but is resilient and highly elastic. These properties peculiarly adapt it for covering the articular ends of the bones, rendering the motions of the joints light and easy, and breaking or lessening the effects of those concussions to which the body is necessarily exposed. The same properties retain the parietes of the larynx, trachea, and meatus auditorius, in a permanently open state.

When a thin lamina of cartilage is examined with magnifying powers, it is found to be composed principally of a clear, homogeneous, or hyaline substance, or matrix, which contains a number of minute cells scattered through it at irregular intervals. These cells or cartilage corpuscles are of different forms, oval, oblong, polygonal, and more or less flattened. Their parietes, in some instances, are indistinct, and the cells appear as hollowed out of the matrix; in others they are membraneous, and blended with the connecting cellular tissue. The cells contain nuclei and neucleoli; some also have oil globules and some granular matter; their average diameter is 1-1500th part of an inch; they are sometimes isolated, sometimes grouped in clusters. In the temporary cartilages those cells near the new bone are larger than those near the surface; the latter are long, slender, and parallel to the long axis of the cartilage. At first the matrix appears more homogeneous or structureless, but, as the ossific changes are about to occur, the cells enlarge, become more distinct, contain oil globules, and the intercellular tissue appears opaque, yellowish, and fibrous. In the articular or incrusting cartilage the cells near the surface are flattened and parallel to it; those deeper or nearer the bone are narrow, oblong, and vertical; hence, when an articular cartilage is cut or broken in a line perpendicular to the surface, the fracture appears striated or columnar. This arrangement must render the cartilage more resistant and elastic in that direction in which weight and pressure are most

likely to operate. The free surface of these articular cartilages is generally considered as covered by a fine epithelium, continued from the synovial membrane. This structure, however, cannot be demonstrated by dissection or maceration; it is rather inferred from analogy and from pathological appearances. This membrane can be traced from the margins of the bones over the borders of the articular cartilage, but the eye can follow it no further. The articular cartilages have no tendency to ossify; but in cases of chronic rheumatism or chronic arthritis, the consequence of injury or disease, they are frequently absorbed, and the bone becomes covered by a hard, ivory, porcellaneous, or enamel-like coating, which is often grooved or channelled in the direction in which motion took place. In the costal and laryngeal cartilages the cells are of large size; those near the surface are flat, and parallel to it; those more internal are oblong and radiating. The matrix is clear, except where fibres have been developed; it is there opaque and yellowish. These cartilages are prone to the ossific change. The aural and nasal cartilages are much less dense; they are more opaque and yellow, more flexible and elastic, and are very seldom changed to bone. The matrix of the cells is very fibrous, the fibres interlacing in every direction. The same structure prevails in the fibro-cartilages, which bodies possess great strength and toughness, combined with flexibility and elasticity; neither have these any tendency to ossify.

Cartilage, according to Schwann, is developed in the following manner. A transparent intercellular tissue, or blastema, is first formed, much softer than the future matrix. In this, nucleated cells are seen at a very early period; these increase in size and number; their growth is chiefly endogenous, that is, young cells are produced within others, whilst the parietes of the latter become increased in thickness, or become blended with the matrix. The intercellular or hyaline tissue, at first but small, increases in quantity and consistence. In this, new cytoblasts are developed, from which proceed new cells with nuclei; and in some situations the matrix becomes fibrous.

All cartilages, except the articular, are covered by a fibrous membrane named perichondium. This adheres very intimately to the tissue, and in the fibro-cartilages is prolonged into its interstices. Nerves cannot be traced by dissection into cartilage, and it appears to possess but little sensibility. In disease, however, of the articular cartilage, pain is often excruciating; in such cases, however, it is not improbable that the osseous and synovial tissues are either directly or sympathetically engaged. In the normal state cartilages appear nearly extravascular; they are nourished by the vessels of the adjoining textures. In the joints a vascular circle surrounds the margin of the articular cartilage, but the vessels are not prolonged into it. In the temporary cartilages, when the ossific process is in progress, red vessels can be traced through the former, and these freely admit injection. In thick cartilages, as in those of the ribs, canals may be seen which contain bloodvessels, particularly if ossification be in progress.

Cartilage contains about one-fourth part of its weight of water; when dry it is transparent, and of an amber color; its solid portion consists of chondrin and gelatin, and small portions of different mineral substances. Cartilage is resolved, by long boiling, into the proximate animal element named chondrin, which has a close analogy to gelatin, but is distinguishable from it. Like it, it is soluble in boiling water, and partially coagulates on cooling, and dries into a transparent glue; but these latter changes are less perfect, and require a longer time than in the case of pure gelatin; neither is it precipitated when in solution, by tannic acid, but is by acetic acid, alum, and acetate of lead, substances which do not affect gelatin. Fibro-cartilages always, and the temporary cartilages only after ossification has commenced, yield gelatin as tendons do under long-continued boiling. The ashes of incinerated cartilages

yield in 100 parts: carbonate of soda, 35.07; sulphate of soda, 24 24; chloride of sodium, 8.23; phosphate of soda, 0.92; sulphate of potash, 1.20; carbonate of lime, 18.37; phosphate of lime, 4.06; phosphate of magnesia, 6.91; oxide of iron, 1.00.

Bone is the firmest and hardest material in the body, and contains less fluid in its composition, except, perhaps, some portions of the epidermoid tissues; it is opaque and whitish, with more or less of a reddish tint, which varies in different situations and at different ages. The more dense and old the bone is, the whiter is its color; the softer and younger it is, the more the red or vascular hue prevails; if dried, without previous maceration, it retains the red color, but otherwise it becomes white. Bones, though very firm, possess a certain degree of flexibility and elasticity, and much more in the young than in the old. The ribs retain these properties through life. Bones are covered by a compact fibro-cellular membrane, named periosteum; this adheres closely to them, is prolonged into their tissue, and serves as an extensive surface for the minute divisions of the nutrient arteries.

The physical properties of bone depend on the peculiar combination of an inorganic earthy material with the animal or organized texture. These two ingredients can be separated and examined distinctly. By slow and careful calcination all the animal matter of a bone may be burned out, and a white, brittle, earthy mass will remain, of the form of the original, but much lighter, about one-third of the weight being lost. Long-continued boiling, also, will extract the greater portion of the animal matter, and the earthy will remain of the form of the original. By macerating a bone for a short time in dilute muriatic or nitric acid, all the saline and earthy parts will be dissolved out, and the residual animal matter will present a tough, flexible, and elastic substance, somewhat like cartilage, retaining the shape and size of the bone. The firmness and density of bone, therefore, depend on the earthy ingredients; but the cohesion between the latter, and the general flexibility and elasticity of the whole, depend on the animal matter. In young bones the latter prevails, in old ones the former; hence the latter are more liable to fracture than the former. The proportion of these elements varies also in different bones in the same individual; thus the petrous bones abound in the earthy material; the long bones of the limbs and the flat bones of the head possess more of it than the vertebræ or ribs; and the humerus and femur more than the bones of the forearm and leg. The earthy ingredients of bone constitute, on an average, about two-thirds of its weight, or about 66 parts in 100. The 66 parts of bone-earth consist of about 51, phosphate of lime; 11, carbonate of lime; 2, fluoride of calcium; 1, phosphate of magnesia; and 1, soda and chloride of sodium. The animall matter amounts, on an average, to about 34 in 100 parts, and resembles cartilage in some respects; it differs from it, however, in being more soft and flexible, and being resolved by boiling chiefly into gelatin instead of chondrin.

Bones present upon their surface numerous foramina and various irregularities. The foramina are chiefly for the transmission of bloodvessels: one or two of some size may be observed in the shafts of the long bones, slanting obliquely into them, and dividing into numerous canals, which lead to the medulla. The artery which this foramen conducts is incorrectly named the "nutritious artery of the bone;" it ought rather to be of the "medullary membrane." This canal in the humerus, tibia, and fibula, slants downwards, but in the femur, ulna, and radius, upwards. The whole surface of a bone is studded with minute holes, which transmit small vessels and fibres of the periosteum; and around the articular ends of bones are several large openings for the entrance of vessels.

The irregularities on the surface of bones are either grooves or pulleys, or processes, such as spines, crests, tubercles, &c. These are for the attachment

of ligaments and muscles, and are better marked in the adult and in the male than in the child or the female; they bear a ratio to the general muscular development, and greatly depend on the previous habits of the individual, as to labor or muscular exertion, or the contrary. Most of the long bones consist for many years of three or more pieces, the shaft and the epiphyses. These separations admit of ossification taking place in a greater number of situations; they also insure increase in length and development in proper proportions in the different regions of the bone. The form of the different bones is too variable to admit of any accurate arrangement; they are, however, generally classed into long, flat, and irregular.

The *long bones* are placed in the extremities; they are very strong and hard, more or less cylindrical. Their centre or shaft is small, and composed of a shell of dense, compact tissue, which is partly hollow within, and filled with fat or marrow, thereby combining strength and lightness, and affording sufficient space for the muscles and other soft parts; whereas the ends are expanded into large and irregularly shaped surfaces, which are covered by smooth, incrusting cartilage, and articulate with other bones. The shafts are not perfectly cylindrical or straight; they are usually a little twisted or curved, as if they were bent when in a soft and growing state; and they generally present a prominent ridge or spine on the concavity, or on that side of the curve in which the bone would be most likely to yield under weight or pressure. The long bones support the weight of the body, and serve as levers whereby the muscles execute the various motions of the limbs. The humerus and femur, tibia and fibula, radius and ulna, are the longest of this class; the phalanges of the fingers and toes are the shortest.

The *flat bones* are those of the cranium and pelvis, also the scapulæ and the ribs. The latter, though long, yet are flattened, and resemble in structure the bones of this class. The flat bones are thin, and composed of two plates or tables of compact tissue and an intervening osseus reticular texture, named diploe. The tables in the cranial bones are much more dense than in the others, and the inner is so hard as to be named vitreous. The flat bones assist in bounding cavities and protecting important organs; they also present an extended surface for muscular attachment.

The *irregular bones* are the vertebræ, those of the carpus and tarsus, of the base of the skull and of the face, and are very variable in form and texture. They are generally composed of reticular tissue, covered by a thin, compact lamina. Those of the face are more dense and compact than the others. These bones afford strength and solidity of support, as in the head; in other situations they also admit of slight and divided motions, and obviate or diminish the shocks and concussions to which the frame is constantly exposed.

If any bone be divided, the section exhibits two forms of *osseous tissue*, the compact and the cancellated. The *compact* is on the external surface, in the form of a hard, dense lamina, of considerable strength and resistance, but varying in different bones. The *cancellated* presents a loose, spongy texture, and is composed of fine bony plates or laminæ, meeting and crossing in every direction, so as to form a reticular or cancellated network, the cells communicating freely. The strongest bars or laminæ run perpendicular to the surface, that is, in the direction best adapted to resist weight or pressure. The compact tissue always incloses the cancellated (the turbinated bones in the nose are an exception), and is continuous with it, so that the two tissues are essentially the same; and, though apparently so different, yet they only differ in the degree of condensation. The most compact tissue, when examined with magnifying powers, is by no means a homogeneous solid, but is full of minute cells or spaces, and it gradually shades off into the cancellated, which occupies the central portion and the expanded extremities of the long bones. In the flat bones the compact tissue is in the form of two plates or tables,

the cancellated tissue or the diploe intervening; and the irregular bones consist of a mass of the cancellated, invested by one continuous lamina of compact.

The canals in the interior of the shafts, and the cells in the cancellated tissue, are lined by a fine membrane, which secretes and supports the *medulla.* Like the periosteum, it is very vascular, and contributes to the support and nourishment of the bone. These two membranes not only cover the external and internal surface of the bone, but also accompany the nutrient vessels along the canals, which traverse even the most compact portions, and are continuous with each other. The medulla, or marrow of bones, is a soft, oily, or adipose secretion, lodged in the fine vesicles of the membrane; it serves to fill the spaces in the bone which are left for the purpose of lessening its weight. In birds these spaces in most of the bones are filled with air; in the human subject the cells and sinuses in some of the bones of the head and face are similarly occupied. In the fœtus the bony cells are filled with a reddish serous fluid instead of marrow. As bone is so highly organized a tissue it must be furnished with bloodvessels; these are numerous, and admit of injection and demonstration; they divide on the periosteum, and enter the bony tissue by many branches, which ramify through it in every direction. Large branches can be traced into and through the cancelli in the extremities of the bone. In the compact tissue capillary vessels run in those minute tubes, named Haversian canals, which branch through the bone, and inosculate with each other and with the cells in the cancelli. The large vessel which slants obliquely through the shaft divides into ascending and descending branches; these end in anastomosing capillaries, which supply the medullary membrane and the interior of the bone. The larger veins in bones usually occupy distinct canals, which are larger than the arterial, and present occasional dilatations like sinuses. In the irregular bones, as the vertebræ, and in the flat bones of the cranium, the venous canals can be very distinctly traced in the cancellated structure, as accurately described by Breschet, and open on the surface by distinct foramina. Although nerves cannot be followed into the osseous structure, yet there can be no doubt of their existence in it, and this opinion is confirmed by the pain which attends disease on the surface or in the substance of a bone.

Osseous tissue consists essentially of a vascular membrane containing a minute capillary network of bloodvessels. This membrane is involuted into numerous canals and cells: its surface is thereby extended to a great degree, and the nutrient vessels conducted through every part of the bone. The bony particles, when examined under high magnifying powers, appear to be as very minute granules cohering together. These granules are aggregated into spiculæ, and various other forms. Between these are numerous pores, which extend from the surface as minute canals into the substance; these anastomose with adjacent ones, and here and there dilatations or *lacunæ* exist. From these other canals pass off still deeper, and join similar lacunæ, and thus permeate the entire bone, running in every direction, and communicating freely with each other. These lacunæ have been most minutely described by Mr. Tomes (*see* Encyclop. of Anat. and Phys., art. "Osseous Tissue; also Todd and Bowman's Physiology, of Man, page 110). Their figure is that of a flattened oval; their length is about 1-1500th of an inch; and they are about half as wide, and one third as thick. The tissue, thus studded by thousands of these lacunæ, which are mostly parallel to the surface, admits of being easily split into parallel laminæ, particularly in old bones, after maceration in dilute acid. This lamellated structure is generally very evident near the external and internal surfaces of the long bones: they are partly concentric, but here and there the lamellæ run into one another. In some of the flat bones, after long maceration and drying, the lamellæ can

often be easily separated by a needle, breaking the connecting rods of Haversian tubes, which permeate the bone and communicate with the lacunæ. In sections of long bones concentric rings can often be separated by the same process. All this apparently complex arrangement appears to depend on the disposition of the vascular membrane, and the necessity of extending it through all parts of the texture. The entire vascular surface in any of the long bones may be considered as "consisting, first, of the outer surface or the periosteum; second, of the inner surface or medullary membrane; third, of the Haversian surface. The exterior or periosteal layer derives its nourishment from the periosteum; the lacunæ of this layer face that surface, and the pores of the superficial ones open upon it. The lacunæ of the medullary laminæ face that surface towards the medullary canal. This layer is variously folded to form the plates and fibres of the cancelli. The Haversian surface is an involution of the outer and inner surfaces, and unites these with one another. When a vessel enters the compact tissue from the external surface, it carries with it a sheath of bone from the periosteal layer. The laminæ of this sheath face inwards towards the vessel, and, wherever the latter penetrates, it is accompanied by this sheath from the periosteal layer, or by offsets from it; and when it enters the medullary canal its sheath expands into the medullary membrane."—*Phys. of Man*, page 111. An analogous arrangement exists in the cancellated tissue; each cancellus may be regarded as a small medullary cavity, containing medulla and a vascular membrane. The plates of bone forming its walls consist of fine lamellæ, among which lacunæ are scattered, and, in some, fine Haversian canals. This delicate organization and extended vascular arrangement form a striking contrast between the cartilaginous and osseous tissues. The temporary cartilages possess the form and preserve the outline of the skeleton; these continue to grow and increase in size, but the processes, grooves, and other irregularities, are not so well marked as in the future bone. Interesting changes occur in the progress of the conversion of these cartilages into bone; these constitute the *process of ossification,* and are necessarily involved in much obscurity. They have been accurately observed and minutely described by J. Tomes (Encyc. of Anatomy, art. "Osseous tissue;" also in Todd and Bowman's Phys., p. 115; and in Quain's Anat., vol. ii. p. cxlvii.) Although ossification usually occurs in cartilage, it is not to be inferred that the latter is actually converted into bone; the latter may be formed independent of the former, as in adventitious bony deposits, and in the flat bones of the head, also, there is but very little cartilage developed, and the ossific process chiefly occurs between membranes. In the temporary cartilages of the long bones, about the period of the ossific change, the cartilage cells or corpuscles are found to become arranged in nearly parallel rows or columns in the length of the bone, having between them intercellular spaces. At the ends of the columns the cells are flattened; the cells or corpuscles themselves are also separated by inter cellular tissue; the parietes of the cells increase, but their central portions diminish to mere nuclei, or small granular cavities. The osseous tissue is deposited in the form of minute granules in all the intercellular tissue, which thereby becomes more dense and opaque. This is the first stage. In the second the parietes of the cells become osseous and granular, and their central cavity disappears; and the third stage consists in the absorption of the osseous matter between the cells. By this change the columns are converted into tubes, marked by indentations, contractions, and dilatations, corresponding to the cells. These elongated tubes are the rudimentary Haversian canals, and they communicate with other similar tubes, and thus a free system of anastomoses is established. The central nuclei or cavities of the cells disappear, and there remain small spherical granules, like lymph globules, of a reddish tint. These form that reddish, semifluid mass found in young bones. These globules are considered

by Todd and Bowman as a sort of blastema, for the development of blood-vessels. After the formation of the osseous tubes, small cells or lacunæ become developed, which communicate with the former. In the epiphyses an analogous change takes place; the cartilage cells or corpuscles are arranged in clusters, with intercellular tissue; ossific matter is deposited in the latter around and between these cells, and thus the large extremity of the bone is formed. In the flat bones, although the process appears to be, as it really is, between membranes, yet it is essentially the same. There is an intervening fibrous and granular tissue, apparently composed of cellular and white fibrous tissue, with numerous corpuscles or cells. The osseous granules are deposited in the intercellular tissue in the form of minute fibres, which extend in radiating directions, at the same time crossing and interlacing, so as to form a reticular texture. It also increases in thickness, and by degrees the more compact tables are formed and the numerous canals containing blood-vessels. Along the margins the membraneous tissue in the more advanced stages is thick and dense, and resembles a thin lamina of cartilage. Once ossification has commenced, it gradually extends by a repetition of the same changes; new cartilage cells, with intercellular tissue, become developed on the surface; ossific matter is deposited, and canals and lacunæ formed, and an appearance of laminated arrangement is produced; the laminæ, first formed on the inner surface of the early cancelli, are pushed outwards by succeeding ones, while a general increase takes place from interstitial growth and from addition to the surface; while at the same time longitudinal extension takes place in the cartilage between the shaft and epiphysis. While this general augmentation in size is in progress, the internal cancelli become enlarged, and open into each other, so as to form the medullary canal, with which the surrounding cancelli communicate; the medullary membrane becomes developed, and fat vesicles are formed, and a large vessel, the nutrient artery, is permanently distributed to it.

The process of ossification commences at a very early period of embryonic life, but not in all parts of the skeleton at the same time. So soon as the end of the first month, the clavicle and lower jaw are partly ossified: at the end of the second it has commenced in the shafts of the long bones of the limbs; also in the ribs, in portions of the vertebræ, of the base of the skull, and of the pelvis. From this on to the period of birth it not only advances in these, but also extends to the other cartilages of the skeleton; and there are only a few in which the process has not commenced previous to that period, such as the patellæ, and some of those of the carpus and tarsus. The ossific process, also, proceeds much more rapidly in some bones than in others, and in some portions of particular bones. In the long bones ossification advances in the shaft much more quickly than in the epiphyses; and many years elapse before the latter are united to the former. By this plan strength is early imparted to the shafts, so as to support the muscles; and longitudinal extension, and increase in the general height is facilitated. The cavity of the cranium, of the spinal canal, the foramen magnum, and many other parts, are constituted by the slow union of several osseous pieces, whereby an equable increase in size is secured; and the sutures in the flat bones answer a similar purpose to the epiphyses in the long ones. In some bones the ossific process commences in one point, and extends from that in all directions; in others it commences in several points, and at a distance from each other. These peculiarities will be noticed in the descriptive account of the individual bones.

SECTION II.

THE VERTEBRÆ.

As the spine forms the foundation or the basis of support for all parts of the frame, it claims priority of attention; it is also the distinctive character of that large division of the animal creation named *vertebrata*, and, together with the cranium, which may be regarded as an expanded prolongation of the vertebral column, contains the great nervous centre, or the cerebro-spinal axis, on which depend so many of the superior characters of this great division of the animal kingdom.

The *vertebræ* are twenty-four in number; they belong to the class of irregular bones, are placed one above the other, and connected by ligaments so as to form one strong, yet flexible column, situated in the middle and back part of the trunk, extending from the head to the sacrum, and inclosing the spinal cord and the roots of the spinal nerves. The sacrum and coccyx, from their likeness to the true vertebræ, have been named the "false vertebræ." All the true vertebræ agree in the general outline, which is as follows. Each vertebra consists of a body and of several projections or processes. The *body* occupies the anterior or central part; it is thick and spongy, and rather circular or oval; its upper and lower surfaces are flat, or slightly concave, and give attachment to the intervertebral ligaments. The margin of each is tipped with a compact white substance, and the lower surface is rather larger than the upper. Anteriorly it is transversely convex, and grooved horizontally, particularly on either side, and is also very porous. Posteriorly it is concave, so as to form part of the spinal canal or foramen. This surface is perforated by large foramina for the escape of the venous canals, which ramify through the bone. The processes of each vertebra are nine, two lateral or the laminæ, two transverse, four oblique or articulating, and one spinous.

The *lateral processes* or *laminæ* arise, one on each side, by a sort of *pedicle* from the posterior part of the body; they pass backwards, bounding the sides of the spinal hole, and unite posteriorly in the spinous process; they are broad behind, but narrow where they join the body, being grooved out above and below into a notch. The inferior of these is the larger. The laminæ form the lateral and posterior portions of the spinal arch or foramen for the spinal cord. The roots of these laminæ, or the pedicles, are considered by some as separate portions; they form the common point of support for the other processes, and separate the superior from the inferior notch. These *notches*, when the vertebræ are joined, form the intervertebral holes for the passage of the spinal nerves.

The *spinous process* is the most projecting part of the vertebræ in the posterior median line; its base is bifurcated, and passes into the two laminæ; its apex generally ends in a point or tubercle. The whole series of these processes presents the longitudinal prominent crest posteriorly named *spine*. Each process receives the insertion of tendons, and serves as a lever for the extensor muscles of the column.

The *transverse processes* arise from the roots of the laminæ, or rather from the pedicles, and are directed outwards on each side; they serve for the attachment of tendons, and in the dorsal region they also support the ribs

The *articular* or *oblique processes* are four in number; they arise from the roots of the transverse, or from the pedicles; two ascend, two descend. They are covered with cartilage, and articulate with the corresponding processes of the vertebræ above and below. The two superior are directed more or less backward, and the two inferior more or less forward; their direction

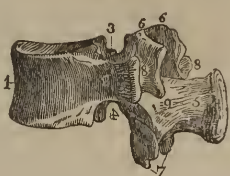
is rather vertical, therefore contrary to that of the surfaces of the bodies, beyond the level of which they extend, so that their articulations correspond to the intervertebral ligaments.

The *spinal hole* or canal is bounded by the body and processes; it is more or less triangular.

The *processes* are of a more compact structure than the body, which is very light and cellular. A vertebræ is generally developed by three points of bone, one for the body, and one for each side for the laminæ and articulating processes: sometimes a fourth point is deposited in the root of the spinous. This process is seldom found ossified in the fœtus, but remains cartilaginous for some time. In addition to these three principal ossific nuclei there are several accessory points or epiphyses, namely, one for the summit of the spinous and of each transverse process, and one for each surface of the body. These latter form thin plates, the rim or margin of which project horizontally beyond the front and sides of the bone. The primary nuclei appear very early in uterine life. From the lateral are gradually formed the articulating, the transverse, and the spinous processes. About five or six years of age the laminæ join the bodies; the accessory epiphyses do not appear until fourteen or fifteen years of age, and are not completely joined to the body until twenty-five. These are the general characters of all the vertebræ, but each of the three classes presents some peculiarity.

The *lumbar vertebræ* are five. These are the largest in the column. The *body* of each is very broad transversely compared with its height, and is deeper before than behind. Its upper and lower surfaces are flat, and bordered with hard, projecting edges, which render it concave from above downwards on its forepart and sides. The *laminæ* are thick, broad, but short. The *notches*, particularly the lower, are very large. The *spinous process* is broad, flat, and square, and ends not in a point, but in a thick, rough border. The *articulating processes* are oval, strong, and vertical. The superior are concave, look inwards, and a little backwards; the inferior are convex, look outwards, and a little forwards; are nearer to each other than the former, and are, therefore, received into those of the vertebra below. The *transverse processes* are long, thin, and horizontal, or directed slightly backwards, and are anterior to those of the dorsal vertebræ, but posterior to those of the cervical. They are sometimes tipped with a tubercle or epiphysis, like a rudimentary abdominal rib. Some consider all these transverse processes as lumbar or abdominal ribs, and regard as true transverse processes, analogous to those in the dorsal region, those small, flattened tubercles which project upwards and backwards from the superior articular processes. These are also sometimes named posterior transverse processes. The spinal foramen is triangular, and larger than in the back. The body of the fifth lumbar vertebra is cut off very obliquely below, so as to be much deeper before than behind. Its transverse processes are short, thick, strong, and rounded. The inferior articular processes are flat, directed forwards, and are further asunder than in the other vertebræ.

Fig. 75.*



The *dorsal vertebræ* are twelve in number, and of an intermediate size between the cervical and lumbar: they decrease from the first to the fourth, and then increase to the last, so that the fourth and fifth are the smallest.

* Lateral view of a lumbar vertebra. 1. The body. 2. The lamina or pedicle. 3. The superior intervertebral notch. 4. The inferior intervertebral notch. 5. The spinous process. 6. The superior articular processes. 7. The inferior articular processes. 8. The transverse process. 9. Tubercle projecting from the articular process, which gives attachment to the sacro-lumbalis and longissimus dorsi muscles.

The *body* is thicker behind than before, and, in most, longer from before backwards than transversely, flat above and below (except that of the first, whose upper surface is concave from side to side); convex anteriorly, and very concave posteriorly. On either side it presents two small depressions or notches, covered with cartilage: the superior is the larger. When the vertebræ are conjoined, two of these notches form an oval depression for the head of each rib. The *laminæ* are broad and thick; the *notches* are large, and anterior to the oblique processes; the inferior is much larger than the superior; the *transverse processes* are long and large, and directed backwards. On the front of each, near the end, except of the two last, there is a small depression covered with cartilage for articulating with the tubercle of the rib. The *oblique processes* are vertical, the superior directed backwards, the inferior forwards. The *spinal hole*, or canal, is small and oval. The *spinous processes* are long, of a prismatic or triangular form, bent downwards very much, and imbricated; also tubercular at their extremities. The first vertebra has the body long transversely, and on either side a full depression above for the head of the first rib, and half of a similar cavity below for the upper part of the head of the second rib. Its spinous process is thick, long, and horizontal, and its articular processes are oblique. The tenth has also a full depression on its body for the tenth rib; the eleventh and twelfth in like manner: these two last also want the articulating depressions on the transverse processes, and they somewhat resemble the lumbar vertebræ in the shape of their body, and inferior articular processes.

Fig. 76.*

Fig. 77.†

The *cervical vertebræ* are seven in number, and smaller than the others. Their *body* is long transversely, a little deeper before than behind. The lower surface is concave from behind forwards; the upper is larger or broader, and concave from side to side. The structure is more compact than in the dorsal and lumbar. The *laminæ* are long and narrow, sharp and small superiorly, round and large inferiorly, so as to overlap those below. The *spinal hole* is large and triangular. The *notches* are small, and anterior to the articular processes in all, except on both surfaces of the atlas, and of course on the upper surface of the second. They are nearly all of equal size above and below. The *spinous process* is short, horizontal, and bifid. The *transverse process* is short, bifid, grooved above for the nerves, and perforated near its base by a round hole for the vertebral vessels. It is on a plane anterior to the transverse processes of the back or loins, and appears, on account of its foramen, to have a second or anterior root from the body of the vertebra, and which may be considered as the rudiment of a cervical rib. The posterior root is the true transverse process, analogous to those in the dorsal region. The *articular processes* are oblique; the superior oval, slightly convex, look

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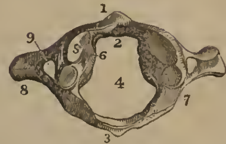
* A lateral view of a dorsal vertebra. 1. The body. 2. 2. Articular depressions for the heads of the ribs. 3. The lamina. 4. The superior intervertebral notch. 5. The inferior intervertebral notch. 6. The extremity of the transverse process marked by an articular depression for the tubercle of a rib. 7. The superior articular processes directed backwards. 8. One of the inferior artieular processes looking forwards. 9. The spinous process.

† The superior surface of the fourth cervieal vertebra. 1. The upper surface of the body, concave from side to side. 2. The lamina. 3. The spinal hole 4. The spinous process. 5. The transverse process, perforated near its base by 6. The vertebral hole. 7. The superior intervertebral groove or noteh. 8. The superior articular process. 9. The posterior surface of the inferior articular process.

upwards and backwards; the inferior, also oval, are concave, and directed downwards and forwards.

Fig. 78.*



The first cervical vertebra, or *atlas*, differs from the remaining, in being a mere bony ring, without any distinct body or spinous process. The anterior or smaller portion of this ring is tubercular before, but presents posteriorly a smooth, concave, oval, and articulating surface, which receives the odontoid process of the second vertebra. The superior and inferior margins of this ring give attachment to ligaments. The posterior arch of the ring of the atlas is round and thick, with a tubercle, instead of spine, for the attachment of the recti muscles. The *spinal hole* is very large, and divided into two by the transverse ligament, which arises from two tubercles placed on the inner side of the superior articulating processes. The anterior portion, small, receives the tooth-like process of the second vertebra: the posterior forms the spinal canal. The *laminæ* are thick and round behind, but near the articulating processes are flattened and grooved above for the vertebral artery and first cervical or suboccipital nerve, and below for the second cervival nerve. Before these notches are the *articular processes*. The superior are horizontal, concave, oval from before backwards, look upwards and inwards, and receive the occipital condyles; the inferior are nearly flat or slightly concave, circular, and inclined a little inwards and downwards. The *transverse processes* are long, and end in an obtuse point; the anterior root is slender, the posterior is long and large. The hole between these is larger than in the other vertebræ, and is directed upwards and backwards. From this a groove for the vertebral artery winds backwards round the superior articular process. In the adult the atlas is very compact. In the fœtus its ossification takes place from five points, one for the anterior arch, two for the posterior, and one for each lateral part.

Fig. 79.†

The axis, or second vertebra, is remarkable for the depth of its *body*, which has anteriorly a central ridge between two depressions for muscles; and from its upper part there rises, by a sort of a neck constricted posteriorly, a large, round, dentiform (*odontoid*) process, the forepart of which is received into the small articulating cavity on the anterior arch of the atlas, while posteriorly it presents a small, smooth convexity, which moves against the smooth surface of the transverse ligament of the atlas. The apex is rather pointed: to it and to the sides of this process the lateral or check ligaments are attached. The *laminæ* are very

Fig. 80.‡

* The superior surface of the atlas. 1. The anterior tubercle projecting from the anterior arch. 2. Articulating surface on the posterior surface of the anterior arch for the odontoid process of the second vertebra. 3. Posterior tubercle projecting from the posterior arch. 4. The spinal hole. 5. Superior articular surface. 6. Tubercle for the attachment of the transverse ligament. 7. Groove for the vertebral artery and first cervical nerve. 8. The transverse process. 9. The vertebral foramen.

† The inferior surface of the atlas. 1. The anterior tubercle. 2. The posterior tubercle. 3. The transverse process. 4. The inferior articular surfaces. 5. The intervertebral notch or groove for the second cervical nerve.

‡ The upper surface of the axis, or second cervical vertebra. 1. The posterior surface of the body. 2. The odontoid process 3. The laminæ. 4. The spinous process. 5. The transverse process. 6. The vertebral foramen. 7. The superior intervertebral notch. 8. The superior oblique or articular process. 9. The inferior articular process. 10. The spinal hole.

strong. The superior *notches* are behind, the inferior before the articular processes. The *spinal hole* is large and heart-shaped. The *spinous process* is forked and very strong; its under surface is channelled. The superior *oblique processes* are slightly convex, nearly horizontal, and look a little outwards; they are situated rather on the body of the bone and at each side of the odontoid process, on a plane anterior to the other articulating processes of the spine. The inferior are smaller, flat, and look downwards and forwards. The *transverse processes* are short, arise from the outside of the superior articular processes, are bent downwards, and are not bifid. The hole is directed obliquely upwards and outwards. This vertebra in the fœtus has an additional or fourth point of ossification in the odontoid process. It is articulated directly with the atlas and the third vertebra, and indirectly with the occipital bone.

The *seventh* cervical vertebra is large; its spine is very prominent, and not bifid. Its transverse process is seldom perforated, as in the other cervical vertebræ. When there is a foramen in it it transmits the vertebral vein, and not the artery. In this vertebra an additional point of ossification is found in the pedicle which connects the processes to the body; this sometimes increases beyond the transverse processes of the vertebral column, so as to resemble a supernumerary or a cervical rib.

Thus each class of the vertebræ is distinguished from the others by certain characters impressed upon the bodies and processes of each; so that, from an inspection of any one of these parts only, even when detached, we can determine to which class the bone belonged. Thus the *body of a lumbar* may be recognized by the following. It is large, the transverse diameter is greater than the antero-posterior, and one-third more than the vertical; deeper before than behind; the upper and lower surface flat or slightly concave. The *body of a dorsal* is of intermediate size between the lumbar and cervical; the antero-posterior diameter equal to, if not longer than the transverse; deeper posteriorly than anteriorly; very concave behind, but prominent and almost angular in front; flat above and below; and, above all, two small depressed facettes on the posterior part of each upper and lower border for the heads of the ribs. The *body of a cervical* is small, compact, and firm, on a lower level compared with the processes; flat before and behind; thicker at each side than in the middle; deeper before than behind; greatest diameter transverse; and, above all, the upper surface is rendered concave from side to side by two lateral lips or ridges; and the lower surface is smaller, a little convex from side to side, and concave from before backwards, in consequence of the greater depth in front; so that these bodies fit into each other, and are thereby secured against displacement.

In the *lumbar and dorsal vertebræ* the *pedicles* are strong, and directed backwards; in the *cervical* they are directed outwards, and grooved above for the superior intervertebral foramen or notch. The superior and inferior *notches* are nearly equal in the cervical, but in the dorsal and lumbar the inferior notch, or that beneath each pedicle, is much larger than the superior. The size of the *intervertebral foramina*, and the depth of these notches, are also proportioned to the size of the spinal nerves and ganglions, and to the venous canals which pass through them.

The *laminæ of a lumbar* are very thick, strong, and short, and their vertical diameter is the greatest. Those of a *dorsal* exhibit much the same characters, but in a less degree; and those of a *cervical* are narrow and long, thinner above than below, and placed very obliquely. That of the upper vertebra overlaps or imbricates that of the lower, and thereby protects the side of the spinal canal from injury or penetration. This imbrication is increased in extension of the neck and head.

The *transverse* or *costiform processes of a lumbar* are long and thin, directed

outwards and a little backwards. Those of a *dorsal* are on a plane posterior to the lumbar; are very long and thick, directed outwards, backwards, and a little upwards; enlarged at their outer end, and there presenting anteriorly and superiorly a small cartilaginous depression for the tubercle of the rib. Those of a *cervical* are short and bifid, directed outwards, forwards, and a little downwards; are on a plane anterior to those of the lumbar and dorsal, and on a level with the body, so as to form a broad surface of support for the various organs in the neck. They are pierced near their base by a foramen for the passage of the vertebral artery and vein, with their accompanying nerves from the sympathetic, and are deeply grooved superiorly for the passage of the spinal nerves.

Fig. 81.*

The *oblique* or *articulating processes in a lumbar* are strong and cylindrical. The superior are concave, look inwards and backwards; the inferior are closer to each other, are convex, look forwards and outwards, and are received into the former. Projecting from the superior are the flattened tubercles, named by some the posterior or true transverse processes. Those of a *dorsal* are plane, vertical laminæ; the superior directed backwards and a little outwards, the inferior forwards and a little inwards. Those of a *cervical* are very oblique; the superior looking upwards and backwards, the inferior downwards and forwards; this form and aspect admit of considerable motion.

The *spinous process of a lumbar* is a broad, square, vertical plate, thick below and behind, projecting horizontally backwards. That of a *dorsal* is long, prismatic, or triangular, grooved below, sharp above, directed obliquely downwards and backwards, and ending in a tubercle. These processes overlap or imbricate, and thereby resist extension. That of a *cervical* is short, bifid, triangular, grooved below, and nearly horizontal.

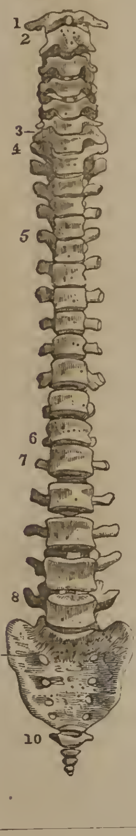
The *spinal hole* or *canal* is largest in the *neck*, particularly in the transverse direction, and of a triangular form, the base in front. In the *back* it is smaller, and circular or oval. In the *loins* it is larger than in the back, but less than in the neck, and is somewhat triangular; but these bodies of the vertebræ are a little concave posteriorly. The dimensions of the canal are proportioned partly to the size of the cord and of the nerves connected with it, and partly to the degree of motion enjoyed in each region.

The column is covered *anteriorly* by the anterior common ligament, and in the neck by the recti and longi muscles; in the back by the last-named muscles above, below by the vena azygos, aorta, &c.; and in the loins by the crura of the diaphragm, the aorta, vena cava, and sympathetic nerves. The anterior surface in the neck is convex forwards and broad, being formed both by the bodies and transverse processes; narrow and concave forwards in the back, and again convex and broad in the lumbar region. *Posteriorly* the column presents, in the median line, the spinous processes, short, horizontal, and separate in the cervical and lumbar, but close and bent over one another

* The vertebral column, sacrum, and coccyx, seen upon their posterior surface. 1. The atlas, or first cervical vertebra. 2. The axis, or second cervical vertebra. 3. The seventh cervical vertebra, or vertebra prominens. 4. The first dorsal vertebra. 5. The fourth dorsal vertebra. 6. The twelfth or last dorsal vertebra. 7. The first lumbar vertebra. 8. The fifth or last lumbar vertebra. 9. The posterior surface of the sacrum. 10. The coccyx, consisting of four pieces. 11. One of the posterior sacral foramina. 12. The inferior aperture of the sacral canal.

in the dorsal region. On each side of these are the vertebral grooves, which are wide in the neck, but deep and narrow in the back and loins. These, during life are filled by the extensor muscles, and, therefore, the spinal region presents a very marked contrast with its condition in the skeleton. In the former there is a median groove or channel, at the bottom of which is the row of spinous processes, and on either side is a thick, longitudinal convexity, formed by the extensor muscles, and covered by the trapezius and latissimus dorsi; whereas in the skeleton the spinal ridge projects in the median line beyond the lateral grooves. These great lateral muscular convexities afford considerable protection to the posterior aspect of the column against external injury or violence. The sides of the column are separated from the posterior surface in the neck and loins by the articular processes, and in the back by the transverse processes. Each side presents to our view portions of the bodies of the vertebræ, with their deep transverse or lateral grooves, and those in the back with the articular fossæ for the ribs; and posterior to these the intervertebral holes, the transverse and oblique processes, and the laminæ. The apertures between the latter are closed in the recent state by the yellow ligaments, and covered by muscles. Outside the posterior grooves in the neck and loins lie the oblique or articular processes; but in the back are the transverse processes, which in this region are on a plane posterior to those in the neck and loins. The intervertebral, or the holes of conjunction in the dorsal and lumbar regions, are before the transverse processes; but in the neck between them, and in the back they are behind the cavities for the heads of the ribs; and they are all anterior to the oblique processes, except those between the atlas and the axis.

Fig. 82.*



The length of the vertebral column is generally about a third of that of the whole body. The lumbar and cervical regions are nearly equal, and each about half the length of the dorsal; the latter commonly measures from ten to twelve inches, and each of the former about five or six. Its general form is that of a pyramid, the base below; but when accurately examined it will be found to represent *three pyramids.* The *first* has its apex in the third cervical vertebra, surmounted by the axis and atlas, and its base is in the first dorsal, which is also the base of the *second* pyramid, whose apex is in the fifth dorsal; where also is the apex of the *third pyramid,* whose base is at the sacrum; the vertebræ diminishing in size about the fourth and fifth dorsal. The column is convex anteriorly in the neck, concave in the back, and convex in the loins. These curvatures are caused partly by the different thickness of the bodies of the vertebræ before and behind, but principally by that of the intervertebral ligaments in these three situations, A perpendicular line passed through the centre of the apex and base of the column will be found anterior to the dorsal, and posterior to the

* The vertebral column, sacrum, and coccyx, seen upon their anterior surface. This plate exhibits the general pyramidal form of the vertebral column, as well as the secondary pyramids. 1. The atlas, or first cervical vertebra, forming the summit of the vertebral column. 2. The axis, or second cervical vertebra. 3. The seventh or last cervical vertebra. 4. The first dorsal vertebra. 5. The fifth dorsal vertebra. 6. The twelfth or last dorsal vertebra. 7. The first lumbar vertebra. 8 The fifth or last lumbar vertebra, articulated to the sacrum, and forming the base of the vertebral column. 9. The sacrum. 10. The coccyx.

cervical and lumbar vertebræ. In the dorsal region there is generally a lateral curvature also, which is usually concave to the left side. This direction of this curve has been by some ascribed to the pressure of the aorta on the left side; by others, and with more probability, to the effect of muscular action, for as the muscles of the right arm are the most used, the points of the spine to which these are attached will be drawn towards that side. In the several violent exertions also, such as pulling forcibly, the body is usually bent to the left side. It has been remarked by some that this curvature is either totally absent or reversed, that is, convex towards the left side, in those persons who are named left-handed, whose left arm is more powerful and dextrous, and, therefore, more used, than the right.

The spine supports the head and chest, and combines strength with lightness and flexibility. It serves as the centre of all the motions of the trunk, and transmits the weight it bears to the sacrum and pelvis; it gives insertion to numerous muscles, and lodges and protects the medulla spinalis in the spinal canal. This canal is large and triangular in the neck and loins, round and contracted in the back. The spinal column in the child is longer in proportion than in the adult, and is nearly straight or perpendicular: in the fœtus the pyramidal figure is reversed, the base being in the cervical and dorsal vertebræ, the apex in the lumbar and sacral. The epiphyses on the surface of the bodies do not exist; therefore the spine, when dried, presents a series of rounded osseous nodules, one below the other.

Fig. 83.*

The false vertebræ are the sacrum and coccyx. The former consists in the child of five pieces; the latter of three or four. The five bones of the sacrum are consolidated in the adult into one, which is, therefore, described as one bone.

The *sacrum*, in the erect position of the body, is directed obliquely backwards and downwards; is a little curved, the lower end being bent a little forwards. The degree of curvature, however, is very variable; it is placed like a wedge in the upper and back part of the pelvis, between the last lumbar vertebra above, the coccyx below, and the ossa innominata on either side. Of a triangular form, the *base* or superior extremity resembles a vertebra, looks upwards and forwards, is very broad transversely, and presents in the middle, an oval surface or body cut off obliquely from before backwards and upwards, and covered with cartilage for articulation with the last lumbar vertebra. Its anterior projecting edge is named the *promontory*. Behind it is the triangular aperture of the sacral or spinal canal, and on each side is a smooth convex surface (or transverse process) directed outwards and forwards, and continuous with the iliac

* Lateral view of the vertebral column, sacrum, and coccyx, to show the curvatures. 1. The atlas, or first cervical vertebra. 2. The axis, or second cervical vertebra. 3. Spinous process of the seventh cervical vertebra, or the vertebra prominens. 4. The first dorsal vertebra. 5. The twelfth or last dorsal vertebra. 6. The first lumbar vertebra. 7. The fifth or last lumbar vertebra. 8. Tuberosities on the posterior surface of the sacrum, corresponding to the spinous processes of the vertebra. 9. The coccyx, composed of four pieces. 10. Lateral articulating surface of the sacrum, or facies auricularis. 11. Convexity presented anteriorly by the cervical region of the vertebral column. 12. Concavity presented anteriorly by the dorsal region of the column. 13. Convexity forward in the lumbar region of the vertebral column. 14. The sacro-vertebral angle or promontory of the sacrum. 15. Concavity presented by the anterior surface of the sacrum.

fossa. The lumbo-sacral nerve and the psoas muscle lie in front of it; it constitutes a portion of the upper or false pelvis on each side. On either side of the spinal canal is the *oblique* or *articular process*, concave, and looking backwards and inwards to receive the articular process of the last lumbar vertebra. Anterior to each is a groove, or notch, which contributes with that in the last vertebra to form the last of the holes of conjunction for the passage of the last of the lumbar spinal nerves. Behind the oblique processes are the laminæ, which are sharp, and give attachment to the last of the ligamenta flava. The inferior extremity, or *apex*, is directed downwards, and sometimes a little forwards, and presents a small, transverse, oval, convex surface, to articulate with the coccyx, behind and on each side of which is a small notch for the last sacral nerve. The *anterior surface* is concave from above downwards, and a little so from side to side, marked by four transverse lines, which indicate its original division into five pieces resembling so many vertebræ (hence sometimes called false vertebræ). The first of these divisions is convex, the remaining are concave. External to these lines, on either side, are the four *anterior sacral holes;* the two upper large, the two lower small; they are all round and smooth, communicate with the sacral canal, and transmit the anterior sacral nerves, veins, and arteries; grooves lead outwards from these, along which the nerves run. These holes are analogous to the intervertebral foramina, and the intermediate grooved bone to the transverse processes in the vertebral column above. External to them is a smooth, depressed surface, which gives attachment to the pyriform muscle. The *posterior*, or *spinal*, or *cutaneous surface*, is narrower than the anterior; is convex and very rough, presenting in the median line four horizontal eminences analogous to the spinous processes, which are often united into one ridge. The first process is generally prominent and distinct, the three next are joined into one ridge, but the lower part of the fourth and fifth spines are deficient, as well as their laminæ, so that the spinal canal appears as a mere triangular channel, which is only closed behind by ligament, and bounded on each side by two tubercles or *cornua*, which descend to meet similar but less developed processes from the coccyx, and convert the notches in the two bones into foramina for the passage of the last sacral nerves. These cornua are sometimes joined by bone to the base of the coccyx. At either side of the median spine is a shallow, rugged groove, the continuation of the vertebral grooves for the lodgment of the tendinous and fleshy fibres of the extensor muscles of the spine. In these grooves are the four posterior holes, opposite to, but smaller and more irregularly formed than the anterior; they transmit the posterior sacral nerves and some bloodvessels. Internal to these foramina, or between them and the spinal ridge, is a row of small tubercles, which are considered by some as representing the consolidated articular or oblique processes, being in a line with the true superior oblique processes on the base of the bone, and with the sacral cornua at the apex, which, being attached to the coccyx, may be considered as inferior ob-

Fig. 84.*

* The anterior surface of the sacrum. 1. 1. The four transverse lines, indicating its original division into five pieces. 2. 2. The anterior sacral foramina. 3. The promontory of the sacrum 4. The articular surface for the body of the last lumbar vertebra. 5. 5. The oblique or articulating processes. 6. The inferior extremity or apex of the sacrum. 7. One of the sacral cornua. 8. The notch for the last sacral nerve. which is converted into a foramen by the coccyx. 9. The ear-shaped surface, which articulates with the ilium. 10. The thin edge which gives attachment to the sacro-sciatic ligaments.

lique processes. Others regard these tubercles as the analogues of the posterior transverse of the vertebræ above. External to these foramina is another row of five tubercles analogous to the anterior transverse processes of the lumbar vertebræ, and these form the bounding line between the posterior surface and the side of the sacrum; these tubercles give attachment to ligaments. The *sides*, or iliac surfaces of the sacrum, are uneven and triangular, consisting of two portions, one superior, broad, and irregular, covered with cartilage for articulation with the ilium; the other inferior, thin, and attached to the greater and lesser sacro-sciatic ligaments. The upper or articulating portion presents anteriorly an irregular surface of a crescentic or ear-shaped form, convex forwards, and directed obliquely outwards, backwards, and a little downwards, and is covered by a thin lamina of cartilage, which is connected to a corresponding surface on the ilium; behind is a very rugged surface for the attachment of the posterior long and short sacro-iliac ligaments.

The *sacrum*, though very thick, is yet light and spongy, and covered by a thin lamina of compact substance; it is long and narrow in the male, broad and short, and more curved inferiorly, in the female. In the latter it is about four inches and a half long; its breadth above is nearly the same, but below only half an inch. Its form and curvatures, however, are very variable, and we cannot always determine to which sex a detached sacrum belongs. The sexual characters are uncertain, and are very differently stated by different writers. In the fœtus the sacrum is nearly straight, and consists of five pieces, in each of which ossification commences in several points. The three superior divisions have five points each, viz., one for the body, one for each lamina, and one for each lateral portion. The two lower portions have three points each, viz., one for each body and one for each lateral portion. Numerous epiphyses are added during the progress of growth; they all become consolidated into one bone about twenty-six years of age.

The *ossa coccygis* are analogous to the caudal vertebræ of animals; are placed at the extremity of the sacrum, and consist of three or four, and rarely of five pieces, which in the old are often united into one or two, but in the young and adult are always distinctly divisible into three parts. We may describe these, however, as forming a single bony piece, which in the adult is triangular, and serves to prolong the curve of the sacrum anteriorly. The *base* above is broad, with a smooth, oval surface adapted to the sacrum, and on either side of this posteriorly is a small horn or process, which is also connected to the sacrum by bone or ligament. Beneath this is a notch for the last sacral nerve. The *apex* is irregularly tubercular, and gives attachment to the muscles of the rectum. The *anterior* or *pelvic* surface is smooth, supports the rectum, and is marked by two or three transverse lines, which indicate its original division into distinct pieces. The *posterior* or *spinal* surface is rough, for the attachment of muscles, and is also marked by transverse ridges and tubercles. The superior of the latter are prolonged to meet the cornua of the sacrum. The *sides* of the coccyx are thin and irregular, marked by grooves and notches, which give attachment to muscles and ligaments. The coccyx is soft and spongy; its ossification commences by four or five points; it becomes united to the sacrum earlier in the male than in the female, and is longer in the former than in the latter.

SECTION III.

THE HEAD.

THE *head* stands at the upper extremity of the vertebral column; is of a spheroid figure, compressed on the sides; it contains the brain, and the principal organs of sense, and is divided into the cranium and the face.

The *cranium*, or skull, may be considered as an expansion of the vertebral canal; is of an oval figure, the narrow extremity before; it contains the brain, and is formed of eight bones, the frontal, two parietal, two temporal, the occipital, sphenoid, and ethmoid. These bones are all closely united by sutures. In some of these are small bones, called ossa triquetra or Wormii. The sutures will be described after the bones have been examined. The frontal is considered as common to the cranium and face; but the temporal, ethmoid, and sphenoid, are equally entitled to this distinction. The anterior region of the skull is named sinciput or forehead; the posterior, occiput; the lateral, the temples; the upper part, the vertex or bregma; and the lower, the base. The frontal, occipital, ethmoid, and sphenoid bones, occupy the median line; the others are lateral and symmetrical; but the single bones also are composed of parts perfectly similar on each side of the median line.

Fig. 85.*

Regarding the cranial cavity as a prolongation of the spinal, completing the receptacle for the great nervous centre, the occipital bone claims our first attention.

The *occipital bone* is curved, and of a rhomboidal figure, placed at the posterior and inferior part of the cranium. It presents two surfaces, an external or posterior or basilar, and an internal or cerebral. The *external surface* is cutaneous in the superior, and basilar in the inferior half; it is convex and smooth above, and presents near the centre the great *protuberance*, of very variable size; to it the cervical ligament is connected. From each side of it leads the *superior transverse ridge*, to which the occipito-frontales and trapezii muscles are attached; midway between this and the foramen magnum is the *inferior transverse ridge*, to which, and to the space between it and the foramen magnum, the recti postici and obliqui superiores are attached; into the rough surfaces between the two transverse ridges the complexi and splenii capitis are inserted. From the tuberosity a spine leads down ver-

* Anterior view of the skull. 1. The superior portion of the frontal bone. 2. The anterior inferior angle of the parietal bone. 3. The coronal suture. 4. The temporal surface of the great wing of the sphenoid bone. 5. The squamous portion of the temporal bone. 6. The squamous suture. 7. The external auditory meatus. 8. The mastoid process or the temporal bone. 9. The malar bone. 10. The ossa nasi. 11. The optic foramen. 12. The foramen lacerum orbitale superius. 13. The spheno-maxillary fissure. 14. The lachrymal fossa, the commencement of the nasal duct. 15. The supra-orbital foramen. 16. The infra-orbital foramen, situated in the canine fossa. 17. The opening of the anterior nares, divided into two parts by the septum. 18. The ramus of the lower jaw. 19. The angle of the lower jaw. 20. The symphysis of the lower jaw. 21. The mental foramen.

tically in the median line as far as the *foramen magnum.* This latter is of an oval figure, and transmits the medulla spinalis and its membranes, the vertebral vessels, and the suboccipital and spinal accessory nerves. It is larger internally than inferiorly. In front of this is the *basilar process,* which is very thick and strong; it passes forwards and a little upwards into the base of the skull, to join the sphenoid bone. Its sides are rough, and contiguous to the petrous bones; it is also rough inferiorly, for the attachment of muscles and the mucous membrane of the pharynx, the roof of which it bounds. Near the forepart of the foramen are the two *condyles,* smooth and oblong processes, covered with cartilage, looking downwards and outwards, and converging anteriorly. Their anterior and inner edges are the deepest, their long axis is from before backwards, in which direction, as also from side to side, they are convex. They are uneven internally near their centre, for the insertion of the lateral ligaments from the odontoid process; they are articulated to the atlas. Behind each of these is a fossa, in which there is generally a small foramen, through which a vein and small artery pass into the jugular fossa; and before them is another fossa, in which there is always a foramen, or a short canal, for the passage of the ninth pair of nerves. External to each condyle is the *jugular eminence,* or *transverse process,* semilunar, bounding posteriorly the foramen lacerum posterius basis cranii, and giving attachment to the rectus lateralis muscle. The *upper angle* is acute; the *edges* very irregular, as also along the sides; ossa triquetra are often entangled in the notches.

Fig. 86.*

Fig. 87.†

The *internal* or *cerebral surface* is concave, lined by dura mater, and marked by two lines, which cross about the centre or opposite the tuberosity, where there is also an internal prominence. These lines bound four fossæ; the two superior receive the posterior lobes of the cerebrum, and are marked by their convolutions; the inferior are smooth, and lodge the hemispheres of

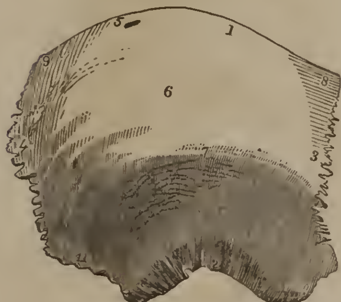
* The external or posterior surface of the occipital bone. 1. The external or posterior protuberance. 2. The superior transverse ridge. 3. The inferior transverse ridge. 4. The external occipital spine or crest. 5. The foramen magnum. 6. The basilar process. 7. 7. The condyles. 8. Rough depression for the insertion of the lateral ligaments of the odontoid process. 9. The posterior condyloid fossa and foramen; the anterior condyloid foramen is concealed in this view by the edge of the condyle. 10. The jugular eminence.

† The internal or cerebral surface of the occipital bone. 1. The internal occipital protuberance, on which rests the Torcular Herophili. 2. The superior vertical ridge, for the falx cerebri, and groove for the superior longitudinal sinus. 3. The inferior vertical ridge, for the falx cerebelli, and groove for the occipital sinuses. 4. The transverse ridge deeply

the cerebellum. To the vertical ridge is attached the falx cerebri above and the falx cerebelli below; the lower extremity of the latter is bifurcated, the upper half is grooved for the longitudinal sinus. To the transverse ridges the tentorium is attached; they are grooved for the lateral sinuses: the right groove is generally the larger. The basilar process is concave from side to side, and slanting from above downwards; it supports the pons Varolii and the basilar artery. On either margin of it is a slight groove for the inferior petrosal sinus. On each side of the foramen magnum, and towards its fore-part, is a light projection corresponding to the anterior condyloid canal. More posteriorly, and above the jugular process, is a groove for the lower extremity or termination of the lateral sinus. This bone is joined to six bones, viz., the two parietal. two temporal, the sphenoid, and the atlas. Its processes are six, namely, two condyles, two jugular, the basilar, and the tuberosity. Its foramina are five proper and two common: the proper are the magnum, the two anterior, and two posterior condyloid; the common are the foramina lacera postica basis cranii. These foramina are completed by the petrous bone; each is divided into two by an osseo-fibrous septum, the small anterior portion transmits the eighth pair of nerves, and the large posterior one, or thimble-like fossa, lodges the lateral sinus as it ends in the jugular vein. The occipital bone presents four angles. The superior is acute, and joins the two parietal bones. The inferior angle, or basilar process, is united to the sphenoid, and the two lateral angles are obtuse, and fit into the angles between the posterior and inferior angles of the parietals and the mastoid portions of the temporal bones. The occipital bone is firm and hard, is composed of two tables and intervening diploe. The external table is thick, but the internal, though thinner is harder, and more brittle or vitreous; the two tables are so close in the fossæ that the bone is diaphanous. The spongy tissue prevails in the basilar process and condyles. It is developed from four points, one for the basilar process, one for each condyle, and one for the upper and back part.

Were we to adopt the transcendental doctrine of the anatomy of the cranium, namely, that its several bones are but expanded and modified vertebræ, we ought to consider the sphenoid and ethmoid bones as next in succession. As, however, it will be more convenient for the student to examine the parietal, frontal, and temporal first, we shall describe them in this order.

Fig. 88.*



The *parietal bones* are symmetrical, and form the upper and lateral parts of the cranium; each is nearly square, convex, and smooth externally, and presents about the centre the *protuberance*, which is better marked in children. Below this is the curved *temporal ridge*, con-

grooved for the lateral sinus: to this ridge the tentorium is attached. 5. Fossa for the posterior lobe of the cerebrum. 6. Fossa for the cerebellum. 7. The upper surface of the basilar process, grooved for the pons Varolii. 8. The foramen magnum. 9. Rough surface of the basilar process which joins the body of the sphenoid bone. 10. 10. Termination of the groove for the lateral sinus. 11. The anterior condyloid foramen. 12. The condyles.

* The external surface of the right parietal bone. 1. The upper or sagittal border. 2. The inferior or squamous border. 3. The anterior or coronal border. 4. The posterior or lambdoidal border. 5. The parietal foramen. 6. The parietal protuberance. 7. The temporal ridge. 8. The anterior superior angle. 9. The superior posterior angle. 10. The inferior anterior angle. 11. The inferior posterior angle.

tinuous with the process of that name on the os frontis; to this the temporal aponeurosis adheres. Below this it is rough for the attachment of the temporal muscle. Of the four *edges* the *upper* or parietal is the longest; it is thick and serrated, and, with the opposite bone, forms the sagittal suture. The *anterior* or frontal *edge* is also serrated, to join the os frontis in the coronal suture; it is slightly concave, and bevelled off externally above and internally below, to meet a corresponding arrangement on the border of the frontal bone. The *posterior* or occipital *edge* is very irregular, slightly convex, and joins the occipital bone in the lambdoid suture. In this suture small bones called ossa Wormii, or triquetra, are often found. The *inferior* or temporal *edge* is the shortest; it is concave and thin, and joins the temporal bone by the squamous suture. Of its four *angles*, the *anterior superior* is nearly right. In the child this is deficient, and the fontanelle exists. The *superior posterior angle* is somewhat rounded. Near this in general is a foramen, which transmits small vessels from the pericranium to the dura mater. The *inferior anterior* is long and curved, and joins the sphenoid bone. The *inferior posterior* is very irregular, and joins the mastoid portion of the temporal bone. The cerebral surface is marked by the convolutions of the brain, and by the branches of the middle artery of the dura mater. This vessel is in a groove, sometimes in a perfect canal or tube in the anterior inferior angle, and from this the branches pass upwards and backwards; a large one ascends a little posterior to the coronal edge. Along the superior border is a groove, which, with that in the corresponding bones, lodges the longitudinal sinus: and near this in the adult skull are irregular depressions for the glandulæ Pacchioni, or the granulations of the dura mater. The posterior inferior angle is grooved, and lodges part of the lateral sinus. The structure of the parietal bone is similar to that of most of the other bones of the cranium, viz., two tables and an intervening diploe, with the venous canals. It is developed from one point of ossification, which is in the parietal prominence; the four angles continue for some years unossified. It is joined to five bones, viz., the frontal, sphenoid, temporal, occipital, and to its fellow.

Fig. 89.*

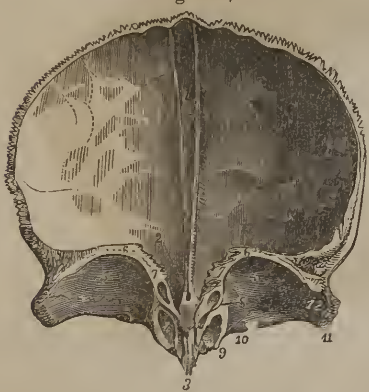
The *frontal bone* is somewhat the shape of one of the bivalve shells; is situated at the upper and anterior part of the skull; forms the forehead, part of the temples, of the orbits, and nose; it is of a semicircular form, convex and smooth anteriorly, concave posteriorly, and irregular below. It may be divided into the *superior* or *frontal* portion, and the *inferior* or *orbital*. The *external surface* of the frontal bone presents in the median line a longitudinal depression; in some not very distinct; in others there is an elevation. This

* The internal or cerebral surface of the left parietal bone. 1. The superior or sagittal margin. 2. The inferior or squamous margin. 3. The anterior or coronal margin 4. The posterior or lambdoidal margin. 5. Part of the groove for the superior longitudinal sinus. 6. The internal aperture of the parietal foramen. 7. The anterior inferior angle of the bone. 8. 8. Grooves for the branches of the middle meningeal artery. 9. The posterior inferior angle. 10. Portion of the groove for the lateral sinus. 11. The anterior superior angle of the bone. 12 The posterior superior angle.

corresponds to the line of union of the two pieces of which the young bone consisted; it is parallel to the longitudinal sinus internally: a suture frequently exists in it, particularly below. At the lower part of this line is the *nasal prominence*, longer in the old than in the young. The bone here is frequently very porous; it terminates in a rough edge for articulation with the nasal and superior maxillary bones. From the centre of it projects the *nasal spine* or *process*, which supports the nasal bone before and the ethmoid bone behind. On each side of this is a groove, which forms part of the superior nasal fossæ. On either side of the median line of the frontal bone, and proceeding from above downwards, we observe, first, a smooth surface, covered by the occipito-frontalis muscle; second, the frontal eminence, which is particularly prominent in the young. Beneath this a slight depression, bounded below by the *superciliary arch*, towards the inner third of which is the supraorbital hole, or notch completed into a hole by a ligament, and which transmits the supraorbital nerve and vessels. From this notch a small foramen leads obliquely into the diploe of the bone. Immediately above the internal third of this arch is the prominence of the frontal sinus, and below it is the edge of the orbit, at each extremity of which are the *angular processes*. The *external* is prominent, and joins the malar bone; the *internal* is thin and broad, covers some cells, and joins the unguis and the nasal process of the superior maxillary bone. Above and behind the external angular, is the *temporal ridge* or *process*, which is prominent below, and leads upwards and backwards to join a similar ridge on the parietal bone; this separates the forehead from the temple, and gives attachment to the temporal muscle and fascia. On the cerebral or internal surface of this portion of the frontal bone we observe in the median line a groove for the longitudinal sinus. Inferiorly the edges of this groove unite into a ridge to which the falx adheres, and which extends down to a small

Fig. 90.*

Fig. 91.†



* The anterior or external surface of the frontal bone. 1. The coronal margin of the frontal bone. 2. The frontal eminence. 3. The nasal prominence. 4. The nasal spine. 5. The superciliary arch. 6. The supraorbital hole. 7. The internal angular process. 8. The external angular process. 9. The temporal ridge. 10. The margin of the orbit.

† The internal or posterior surface of the frontal bone. 1. The groove for the superior longitudinal sinus. 2. The foramen cæcum. 3. The nasal spine. 4. Orifice of the frontal sinus. 5. The inferior surface of the orbital process. 6. The posterior edge of the orbital process. 7. 7. The internal cellular edges of the orbital processes; the space between the internal edges is the ethmoid notch. 8. The anterior and posterior internal orbital foramina. 9. The internal orbital process. 10. The depression for the cartilaginous pulley of the superior oblique muscle. 11. The external angular process. 12. The depression for the lachrymal gland.

hole, the foramen cæcum, which is between this bone and the ethmoid; this foramen transmits a small vein from the nose, and lodges a process of dura mater. On either side of this median line is the frontal fossa, corresponding to the protuberance externally; also numerous irregularities, or depressions and eminences, corresponding to the convolutions and sulci of the brain; these are named the mammillary eminences and the digital impressions; in some of the latter the bone is often very thin. The circumference of the os frontis is thick, rough, and serrated, to join the parietal bones. The tables are cut unequally, the internal being deficient above and in the middle, the external below, so that it rests on or binds down the two parietal bones above, and supports or is overlapped by these below. Below the temporal process it is bevelled off; is thin and rough, and is inserted under and between the laminæ of the ala of the sphenoid bone. The *inferior portion* of the frontal bone presents the deep ethmoidal notch in the centre, in front of which is the *nasal spine*, and the orifices of the frontal sinuses. Its edges are cellular, to unite to and communicate with the cells of the ethmoid bone. Along its margins are two foramina, the anterior and posterior orbital; they are common to this and to the ethmoid bone; the anterior transmits the nasal twig of the ophthalmic nerve and anterior ethmoidal artery; the posterior, the posterior ethmoidal artery. On either side are the *orbital processes*, smooth, concave, and triangular, the apex behind, presenting near the external angular process a fossa for the lachrymal gland, and near the internal a slight depression for the cartilaginous pulley of the superior oblique muscle of the eye; instead of a depression there is sometimes a small spine. The cerebral surface of these processes is convex, but very uneven, marked by the brain and bloodvessels. Their posterior margins are thin, and cut obliquely to support the lesser wings of the sphenoid bone. The processes of this bone, enumerated by anatomists, are eleven, viz., two orbital, four angular, two superciliary, two temporal, and one nasal. The foramina are nine, viz., one, the foramen cæcum; two and three, the frontal sinuses, between the nasal and internal angular processes; four and five, the supraorbital; six and seven, the anterior; and eight and nine, the posterior internal orbital; these last, as well as the foramen cæcum, are often common to this and the ethmoid bone. The os frontis is joined to four bones of the cranium, viz., the two parietal, the sphenoid, and ethmoid; and to eight bones of the face, viz., the nasal, superior maxillary, lachrymal, and malar. The structure is thick towards the nasal protuberance and superciliary ridges, but very thin in the orbital plates. It is composed of two compact laminæ and an intervening diploe. By the absorption of the latter, and the greater separation of the plates, the cavities called the *frontal sinuses* are formed. These do not exist in childhood; in the adult their size is very variable; they generally extend from each side of the ethmoid notch upwards and outwards for one-third of the superciliary arch, and sometimes much further; they are generally separated by a septum; each opens by the infundibulum into the middle meatus or the nose; they are lined by a delicate fibro-mucous membrane, and are filled with air; and while they thus effect an extension of surface, they do not increase the general weight of the cranium. They may contribute in a secondary manner to the sense of smelling, also to the resonance of the voice. The corresponding projections in the superciliary regions materially affect the facial angle and the expression of the countenance. This bone is developed from two points of ossification, one in each frontal prominence; from this, ossification extends in rays, which unite in the middle line, but occasionally a suture remains between them: this has been said, but without sufficient foundation, to be more frequent in women than in men.

The *temporal bones* are situated in the lateral, middle, and inferior parts of the skull, of a very irregular shape, thin above and before, and thick behind and below. Each may be divided into three portions, the squamous, the

mastoid, and the petrous. The *pars squamosa* is the superior division; it is flat, thin, and scaly, forms part of the temporal fossa; is bounded above by a semicircular edge, and below by the *zygomatic process*, which is horizontal, and arises by two roots, one of which is anterior, and covered by cartilage; is narrow externally, broad internally, and runs transversely in front of the glenoid cavity, with a little obliquity backwards, its inner end being on a plane posterior to its outer; the other root passes horizontally backwards, and bifurcates; one portion turns into the glenoid fissure, the other is gradually lost above the mastoid process. Where these two roots of the zygoma, the one transverse, the other horizontal, unite, there is a small *tubercle* to which the external lateral ligament of the lower jaw is attached. The zygoma thence bends forwards and downwards, slightly curved, convex outwards, and ends in a serrated edge which joins and rests on the malar bone. Between the root of the zygoma and the squamous plate there is a smooth trochlea, over which the posterior part of the temporal muscle moves. Behind the transverse root of this process is the articular or *glenoid cavity*, which is crossed by the *Glasserian fissure*. This fissure leads inwards and forwards; into it the capsular ligament of the lower jaw is inserted, and near its centre is a small hole, the opening of the canal through which the corda tympani nerve passes, also the ligament incorrectly named laxator tympani muscle. In this fissure, also, the processus gracilis of the malleus is attached. The anterior part only of the glenoid cavity enters into the maxillary articulation; the posterior is filled by the parotid gland, and is bounded by the *external auditory process and meatus*. The meatus leads inwards and forwards, behind the glenoid cavity, from the external auditory hole, which is between the two divisions of the outer root of the zygoma. It is formed of a twisted plate of bone, united above to the squamous plate, but presenting below a rugged edge to which the cartilage of the ear is attached. The meatus takes a curved direction forwards, inwards, and a little downwards; it is about half an inch long, and narrower in the centre than at the extremities; it leads to the membrana tympani: its external rough lip, or processus auditorius, is grooved internally for the attachment of the membrana tympani. The squamous plate internally is marked by vessels and by the convolutions of the brain, like the other bones of the cranium; its upper edge is bevelled off internally, and is very rough, to overlap the parietal bone.

Fig. 92.*

The *mammillary* or *mastoid* is the posterior inferior portion; is joined to the

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* The external surface of the temporal bone of the right side. 1. The squamous portion. 2. The mastoid portion; the number is placed upon the mastoid process. 3. The extremity of the petrous portion. 4. The zygomatic process. 5. The anterior or transverse root of the zygoma. 6. The posterior or horizontal root. 7. The inferior division of the posterior root, sometimes called the middle root of the zygoma. 8. The articular or glenoid cavity. 9. The Glasserian fissure. 10. The meatus auditorius externus, surrounded by the auditory process. 11. The digastric groove. 12. Groove for the occipital artery. 13. The mastoid foramen. 14. The styloid process. 15. The vaginal process.

parietal bone above and to the occipital behind by very thick and deeply-serrated edges. Inferiorly it is prolonged into a rough, nipplelike process, the *mastoid;* internal to which is a groove for the digastric muscle, and another internal and partly behind it for the occipital artery. Above and behind it is a hole through which a vein and small artery pass. This process is very rough and porous; the diploe is hollowed out between the two tables into cells which communicate with the tympanum. It gives attachment to the sterno-mastoid muscle. The cerebral surface is deeply grooved for the lateral sinus.

The *petrous portion* passes from the junction of the mastoid and squamous forwards and inwards, and a little upwards, into the base of the skull; it is of a triangular form, the base behind, and very irregular, with a deep notch which assists the occipital bone in forming the foramen lacerum posterius. The apex is anterior, contiguous to the body of the sphenoid bone, and completing with it the foramen lacerum anterius, which in the recent state is filled up with cartilage. This bone is peculiarly hard and rugged; it presents three surfaces, an inferior, superior, and posterior. On its *inferior* or basilar surface we remark, in front of the foramen lacerum posterius, a minute hole which leads to the cochlea, and is named the *aqueduct* of the *cochlea.* More anteriorly and externally is the *styloid process,* which descends obliquely inwards and forwards, and gives attachment to three muscles and two ligaments; it is surrounded at its root by a plate of bone most prominent anteriorly and externally; this is the *vaginal process,* it separates the glenoid fossa from the carotid foramen. Behind and outside the styloid process, between it and the mastoid, is the *stylo-mastoid hole,* or the lower end of the aqueduct of Fallopius; this transmits the portio dura, or the facial nerve. In front of the styloid process, and a little internal to it, is the *carotid hole,* which leads into a canal that winds forwards, upwards, and inwards, and which opens within the cranium, above the foramen lacerum anterius, by the side of the body of the sphenoid bone; it transmits the carotid artery and branches of the sympathetic nerve. In front of the carotid hole is a flat, rough surface, to which the muscles of the velum and pharynx are attached. Internal to the styloid process and stylo-mastoid foramen is a vertical ridge or spine, named *jugular,* which joins the corresponding portion of the occipital bone. Internal and posterior to this ridge, in the posterior border of the bone, is the deep *jugular fossa,* which,

Fig. 93.*

* The inferior surface of the temporal bone. 1. The squamous portion. 2. The mastoid portion. 3. The petrous portion. 4. The zygomatic process. 5. The anterior or transverse root of the zygoma forming the eminentia articularis. 6. The superior division of the posterior root. 7. The inferior division of the posterior root. 8. The tubercle to which the external lateral ligament of the lower jaw is attached. 9. The Glasserian fissure crossing the glenoid cavity. 10. The auditory process. 11. The lower extremity of the mastoid process. 12. The digastric groove. 13. The groove for the occipital artery. 14. The mastoid foramen. 15. The stylo-mastoid foramen. 16. The jugular fossa. 17. The styloid process, bounded externally and anteriorly by the vaginal process. 18. The aqueduct of the cochlea. 19. The carotid foramen, in the posterior margin of which is a small opening which admits the nerve of Jacobson, or the tympanic branch of the glosso-pharyngeal nerve. 20. The rough surface to which the levator palati is attached. 21. The angle between the squamous and petrous portions, into which the spinous part of the sphenoid bone is wedged; in it are found the bony orifice of the Eustachian tube, and immediately above it the canal for the transmission of the tensor tympani muscle. The thin plate of bone which separates these openings is termed the processus cochleariformis.

with that in the occipital, completes the *foramen lacerum posticum.* The upper part of the jugular spine separates a smaller portion of this fossa from the remainder. Through it passes the eighth pair of nerves, and through the larger and posterior part the jugular vein. The lower portion of the jugular spine separates the jugular from the carotid foramen; and upon this intervening bone is the small triangular opening of the *aqueduct of the cochlea;* also the orifices for the transmission of the tympanic branches of the glosso-pharyngeal and pneumogastric nerves. The apex of the petrous bone is very irregular; it lies in the foramen lacerum anterius; the internal or superior opening of the carotid canal is in it. Into the angle between the petrous and squamous portions the spinous part of the sphenoid bone is wedged. In this angle there are two holes or canals separated by a thin lamina of bone, named *cochleariform process.* The upper canal transmits the tensor tympani muscle; the lower is the extremity of the bony part of the Eustachian tube; both these canals lead backwards and outwards into the tympanum. The *cerebral surface* of the petrous bone presents a prismatic form; a sharp, grooved, angular ridge, to which the tentorium cerebelli is attached, separates its two surfaces; one looks forwards and upwards, the other backwards and inwards. The superior petrosal sinus is lodged in the groove on the angle of the bone, between it and the tentorium. On the *superior surface* we observe anteriorly a depression, sometimes a notch, which corresponds to the Casserian ganglion of the fifth pair of nerves. Leading from this is a delicate groove which conducts to a small opening, the *hiatus Fallopii,* through which the superior branch of the Vidian nerve passes in order to enter the aqueduct of Fallopius. The remainder of the surface is marked by the convolutions of the brain and by the eminence of the superior semicircular canal. On the *posterior surface* is the *meatus auditorius internus,* a short canal, about a third of an inch long; through it pass the two portions of the seventh pair of nerves; it is directed forwards and outwards, is lined by dura mater, and is terminated abruptly by a vertical bony process, beneath which is a sort of cribriform plate: through this the auditory nerves pass, and above this the portio dura enters the *aqueduct of Fallopius.* The latter is a very long canal, which leads outwards and downwards behind the tympanum; the hiatus Fallopii, and some canals from the tympanum, open into it: it ends in the stylo-

Fig. 94.*

* The internal surface of the right temporal bone. 1. The squamous portion. 2. Its upper edge bevelled off to overlap the parietal bone. 3. The mastoid portion; the number is placed immediately behind the internal orifice of the mastoid foramen. 4. The groove for the lateral sinus. 5. The extremity of the mastoid process. 6. The petrous portion of the temporal bone. 7. The eminence marking the situation of the superior semicircular canal. 8. The ridge to which the tentorium is attached. 9. The notch for the passage of the fifth nerve over the border of the petrous bone, near to its apex. 10. The meatus auditorius internus. 11. The opening of the aqueduct of the cochlea. 12. The small depression lined with dura mater. 13. The slit in which the aqueduct of the vestibule ends. 14. The termination of the canal. 15. The styloid process. 16. The extremity of the petrous bone which gives origin to the levator palati and tensor tympani muscles. 17. The zygoma.

mastoid foramen. Behind the meatus is a small depression lined by the dura mater, and posterior to this is a narrow, short slit, in which the *aqueduct of the vestibule* ends: from this slit a groove descends to the jugular opening. The petrous bone contains within it the ossicula and the complicated apparatus of the organ of hearing, which have been already described (page 538). The temporal bone is connected to five bones, the parietal, malar, sphenoid, occipital, and inferior maxillary, and in some to the os hyoides. The processes enumerated are six, viz.: the mastoid, auditory, zygomatic, styloid, vaginal, and cochleariform. The holes are ten proper and two common. The proper are the external auditory, glenoidal, stylo-mastoid, aqueductus cochleæ, carotid, Eustachian, hiatus Fallopii, internal auditory, and aqueductus vestibuli. The common are the foramen lacerum anticum and posticum or jugulare. In the fœtus it consists of two portions, the squamous and petrous; the latter is large and well developed, and the ossicula auditus which it contains are perfect, and nearly as large as in the adult. The mastoid portion is not formed; the styloid process is cartilaginous, and is distinct from the rest of the bone. The external auditory meatus is wanting; a bony ring supplies its place, and encircles the tympanum.

The *ethmoid bone* is situated in the notch between the orbital plates of the frontal bone, and forms the roof and part of the sides of the nostrils. It is so named from its cribriform or sieve-like appearance; it is of a cuboid figure, and composed of many thin, brittle, semi-transparent laminæ, placed in every direction so as to form cells; these enlarge the surface of the nose without increasing the size or weight, for this bone is remarkably light. It consists of a superior cribriform plate, a middle perpendicular lamina, and two lateral symmetrical portions. The *superior* or *cerebral surface*, or *cribriform plate*, is broad and somewhat square; it is covered by the dura mater. In its posterior edge is a notch, which receives a process of the sphenoid bone. Along the middle line is a hard ridge, which anteriorly rises into a remarkable process, the *crista galli*, to which the beginning of the falx is attached. This process ends before in two short *alæ*, which join the os frontis, and which often assist in bounding the foramen cæcum. On either side of this process is a channel deeper before than behind: these lodge the bulbs of the olfactory nerves. Anterior to each of these, and nearer to the process, is a small slit, which transmits the nasal branch of the ophthalmic nerve. This entire surface is perforated by numerous holes; about ten or twelve of these are large, and are placed over the lateral parts of the bone; the remainder are very small, and are on either side of the median line; they each lead into a small vertical canal lined by dura mater. From the inferior surface of this plate there descend the *nasal lamella* in the middle, and a large spongy cellular mass on either side. The *nasal lamella* is in the median line; it is thick above and behind where it joins the sphenoid, thin below where it joins the vomer and nasal cartilage, and very thick before, where it unites to the nasal process of the os frontis and to the nasal bones. Its sides are marked by the canals for the olfactory nerves, short and oblique before, vertical and very long in the

Fig. 95.*

* The ethmoid bone, seen from above and behind. 1. The crista galli. 2. One of the anterior wings which join the frontal bone. 3. The cribriform plate. 4. The perpendicular or nasal lamella. 5. The lateral masses. 6. The os planum, or orbital process. 7. The superior turbinated bone. 8. The superior meatus of the nose. 9. The middle turbinated or spongy bone. 10. The posterior ethmoidal cells.

middle and behind; they descend for about half the depth of the plate, and there end in mere grooves. On either side of this septum is a deep channel, which forms the roof of each naris. On each side of this we observe an irregular bony structure, which consists of three parts, an internal curved lamina (the superior turbinated bone), a middle range of cells, and externally towards the orbit a smooth, square plate, the os planum. First, the *turbinated* or *spongy bone* is a very thin plate, descending at first vertically, and then bending outwards, and rolled upon itself for nearly half a turn. In the posterior extremity of this is a depression or sort of cleft, which is called the superior meatus of the nose. This channel or meatus extends along the posterior half of the ethmoid; it is closed before, except in a small aperture which leads into the posterior ethmoid cells. The portion of the turbinated plate which extends above this cleft is named *superior spongy* or *turbinated bone*, and that below this fossa *middle spongy bone;* it is larger than the upper portion, more curved, and very concave outwardly. Beneath this is a deep fossa named the middle meatus of the nose. Second, the *ethmoid cells* are external to the turbinated plates, bounded above by the cribriform plate, and externally by the os planum and os unguis; the cells are about twelve or fourteen in number, and are divided by a bony septum into an anterior and posterior set. The *posterior* are small, and open into the superior meatus, and sometimes one of the uppermost communicates with the sphenoid sinus, or opens into the fossa of its turbinated plate. The *anterior* cells are larger and more numerous; they open into the middle meatus. One of the most anterior is curved into a sort of tube, the *infundibulum.* Into this the frontal sinus opens above, and it terminates below, before the orifice of the great maxillary sinus or antrum. All these cells are lined by the pituitary membrane, which, however, is less vascular and thick than that on the nasal lamella and turbinated bones. On this membrane, particularly that covering the superior spongy bone and the square surface before it, the external olfactory canals chiefly end. From the lower surface of the ethmoidal cells thin plates often descend very irregularly to join the superior maxillary. External to the cells on each side is, third, the *os planum*, or orbital plate, very smooth and polished, articulated above to the frontal, before to the lachrymal, behind to the sphenoid, and below to the maxillary and palate bones: the upper border has often a notch or two, which assist the frontal in forming the internal orbital holes. The ethmoid bone contributes to form the base of the cranium, the nose, and the orbits: it has little or no cellular tissue in its composition, except in the crista galli and in the turbinated plates. In the latter the compact tissue is in the centre, and covered by the spongy. It is developed by three points of ossification, one for the central lamella and one for each side; the latter appear first; the turbinated plates are not distinct until five years of age. It is joined to two bones of the cranium, the frontal and sphenoid, and to eleven of the face, the nasal, superior maxillary, lachrymal, palate, inferior spongy, and the vomer.

Fig. 96.*

The *sphenoid bone* is so named from the manner in which it is wedged into

* A lateral view of the ethmoid bone. 1. The crista galli. 2. Its arms or wings. 3. The channels in which are lodged the olfactory nerves. 4 The anterior edge of the perpendicular or central lamella. 5. The os planum, or orbital plate. 6. The anterior ethmoidal cells. 7. The infundibulum. 8. The middle meatus of the nose.

the base of the skull, in the middle of which it is placed; it is articulated to all the bones of the cranium, and to many of those of the face; it is of a very irregular form, and has been compared to a bat, to which it bears some resemblance, particularly if the ethmoid remain attached. It may be divided into a body and procesess. The *body* is in the centre, and resembles a square box. From its median line inferiorly and anteriorly proceeds the *azygos process*, or the *rostrum*, which is received between the layers of the vomer. On each side of this is a small groove for vessels; it is flat and rough posteriorly for attachment to the basilar process. Its centre is hollowed out into two

Fig. 97.*

cavities or sinuses, which are separated by a septum which is continuous with the azygos process. Anteriorly it presents the two small, round openings of the *sphenoid sinuses*, beneath which are often found two small triangular bones, the *spongy* or *turbinated bones* of the *sphenoid*, or of Bertin. The superior or cerebral surface presents several remarkable appearances; it is hollowed from before backwards into the deep depression called *sella Turcica.* This lodges the pituitary body, and is perforated by several holes, through which small vessels pass to the sinus. Posteriorly it is bounded by a thin plate which rises perpendicularly, and has a slight knob at each angle, named *posterior clinoid processes*, to each of which the extremity of the convex edge of the tentorium cerebelli is attached. Anterior to the sella is the flattened or slightly grooved surface for the optic commissure. This leads outward to each optic foramen. The eminence supporting this groove is named the *olivary process.* Behind this, or between it and the pituitary fossa, is a tubercle on each side, named *middle clinoid processes*, or *process*, as some consider it. Behind the optic foramina are the *anterior clinoid processes*, two thick tubercles to which the extremity of the concave edge of the tentorium is attached. Each of these is perforated by the *optic foramen*, which is transversely oval, and transmits the ophthalmic artery and the ophthalmic nerve. Sometimes the anterior is united to the posterior clinoid process by bone, and sometimes to the olivary process. From each anterior clinoid process there extends forwards and outwards a thin plate of bone, the *transverse spine* or lesser wing,

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* The anterior view of the sphenoid bone. 1. The azygos process. 2. The ethmoidal process. 3. The openings of the sphenoidal cells. 4. The turbinated bones of the sphenoid. 5. The lesser wing. 6. The foramen opticum. 7. The foramen lacerum orbitale. 8. The orbitale process of the great wing. 9. The temporal process. 10. The pterygoid crest. 11. 11. The foramen rotundum. 12. The spinous process of the sphenoid. 13. The external pterygoid plate. 14. The internal pterygoid plate. 15. The hamular process. 16. The notch which receives the palate bone. 17. The anterior opening of the Vidian canal. 18. The groove which assists in forming the posterior palatine canal.

or wing of Ingrassius. This is united anteriorly to the frontal bone, and forms part of the orbit; it ends in a point; its posterior edge is thick and rounded; the sphenoidal fold of the dura mater is attached to it, and both occupy the

Fig. 98.*

fissure of Sylvius, on the base of the cerebrum, between its anterior and middle lobes. Each side of the sella Turcica is grooved by the carotid artery. From the forepart of the body of the sphenoid extends a small plate to join the ethmoid bone, the *ethmoidal process.* From each side of the body, the *great ala* is continued outwards, forwards, and upwards; it presents three surfaces, one anterior, smooth, and square, forms part of the outer wall of the orbit, and is named *orbital process;* another is elongated and concave, and, together with the temporal bone, supports the middle lobe of the cerebrum; the third, or external surface, is named the *temporal process.* This is divided into two by a *crest;* the upper part forms a portion of the temporal fossa, and the lower of the zygomatic fossa; some fibres of the temporal and external pterygoid muscles are attached to the crest itself. From the posterior part of each wing the *spinous process* extends backwards, and curves a little downwards and outwards, and occupies the angle between the squamous and petrous portions of the temporal bone; it terminates in a spine, the *styloid process,* on the inner side of the articulation of the lower jaw. Near this process is a small foramen (*spinosum*), which transmits the middle or spinous artery of the dura mater. Anterior to this is the *foramen ovale,* opening directly downwards for the passage of the inferior maxillary nerve. Still more anterior is the *foramen rotundum,* which leads forwards into the pterygo-maxillary fossa, and transmits the superior maxillary nerve. Between the lesser and great wing is a long slit, the *foramen lacerum orbitale,* wide internally, narrow externally, where the frontal bone sometimes assists in closing it; it transmits the third, fourth, first branch of the fifth and the sixth nerves, also filaments of the sympathetic, and the ophthalmic vein and a small artery. From the angle between the body and great ala the *pterygoid* plate descends perpendicularly (fig. 97); internally it bounds the posterior naris, externally the external pterygoid muscle is attached to it; anteriorly the palate bone is connected to it, posteriorly it is hollowed into the *pterygoid fossa,* which lodges the internal pterygoid muscle, and in a small depression internal to this the tensor palati muscle. This fossa thus divides this process into two plates; the *external* is broad and rough, the *internal* is longer and narrower, and ends

* The superior or cerebral surface of the sphenoid bone. 1. The sella Turcica. 2. The posterior clinoid process. 3. The olivary process. 4. The anterior clinoid process. 5. The optic foramen. 6. The lesser wing. 7. The ethmoidal process. 8. Groove for the internal carotid artery. 9. The rough surface to which the basilar process of the occipital bone is attached. 10. The cerebral surface of the great wing. 11. The spinous process. 12. The styloid process of the sphenoid bone. 13. The foramen spinosum. 14. The foramen ovale. 15. The foramen rotundum. 16. The foramen lacerum orbitale. 17. The angle which receives the apex of the petrous portion of the temporal bone; the posterior orifice of the Vidian canal lies in this angle.

in the *hamular* process, a small, delicate hook, convex inwards, concave outwards, and covered by a bursa; round this the tendon of the tensor palati muscle turns. In the inferior notch between these plates the palate bone is received. Above the internal pterygoid plate is the *Vidian hole* or canal. This opens anteriorly on the inner side of the foramen rotundum into the spheno-maxillary fossa, and posteriorly, very small, into the foramen lacerum anterius: it transmits the Vidian nerve and vessels. The structure of the sphenoid bone is very compact, except the body, which is cellular: the latter about ten years of age undergoes the process of absorption, whereby the cavities called the *sphenoid sinuses* are gradually formed. These open on each side into the upper and back part of the nose. In front of them in the adult is a small, curved plate of bone, the *sphenoidal turbinated bone;* it is of a pyramidal form, the base anteriorly connected to the posterior ethmoid cells, the apex posteriorly, and joined to the forepart of the sinus. It lies above the *spheno-palatine foramen,* a hole which is below the body of the sphenoid, and between the orbital processes of the palate bone. This hole leads from the nose to the spheno or pterygo-maxillary space. These superior spongy bones are wanting in the child, and even sometimes in the adult. The sphenoid is articulated to the seven bones of the cranium and to five of the face, viz., the two malar, two palate, and the vomer, and in some cases to the superior maxillary by the pterygoid plates; the palate bones, however, in general intervene. The processes enumerated are twenty-eight, viz.: five clinoid, one olivary, one ethmoidal, two lesser wings, the azygos, two spongy or triangular, two great wings, two temporal, two orbital, two spinous, two styloid, four pterygoid, and two hamular. The foramina are fourteen proper and eight common. The proper are two optic, two lacerated orbital, two round, two oval, two spinal, two Vidian, and the two sinuses. The common are the two foramina lacera antica basis cranii, two spheno-maxillary fissures, one in each orbit, bounded by the orbital plates of the sphenoid, malar, maxillary, and palate bones, two spheno-palatine, and two posterior palatine canals between the pterygoid processes and the superior maxillary tuberosities. At birth the sphenoid bone consists of three pieces; one is the body to which the clinoid processes and lesser wings are attached; the lateral pieces consist of the pterygoid processes and the great wing of each side.

The bones of the cranium are connected to each other by *suture,* that is, the edge of each is serrated or cut into irregular teeth-like processes, which indigitate or lock into each other, so as to unite the two edges in a very strong and motionless manner. The indentations are irregular and oblique in very thick bones, but where the edges are thin the suture is more straight and even; they are more distinct in the young than in the old, and on the outer than on the inner surface of the cranium. There are seven sutures noticed by most anatomists (some, however, unnecessarily enumerate a greater number): the sphenoidal, ethmoidal, coronal, sagittal, lambdoid, and the two squamous.

The *sphenoidal suture* is very extensive; it follows the irregular edge of the sphenoid bone, and connects it to the occipital, the temporal, inferior angle of the parietal, the frontal, and the ethmoid.

The *ethmoidal* suture, in like manner, encircles the ethmoid bone, and connects it to the frontal. The *frontal* or *coronal suture* proceeds from the upper extremity of the sphenoidal, about an inch behind the external angle of the os frontis; ascends vertically, inclining a little backwards, and then descends to the same point on the opposite side; it connects the frontal and parietal bones by serrated edges, alternately bevelled in the manner before explained.

The *sagittal suture* leads from the superior angle of the occipital bone directly forwards between the two parietal to the centre of the coronal suture;

it is deeply serrated about the centre, and is sometimes continued along the median line of the frontal bone down to the nose.

The *lambdoid suture* extends on either side from the posterior extremity of the sagittal suture downwards and forwards to the mastoid process of the temporal bone; and a suture, named the *additamentum of the lambdoid*, continues down between the back part of this process and the occipital and petrous bones as far as the foramen lacerum posterius. The lambdoid suture is very rough, and frequently contains ossa triquetra of very irregular size: it connects the occipital and the two parietal bones. The additamentum is an harmonic suture, that is, it is very little serrated, but presents uneven, thick edges; it connects the occipital to the mastoid and petrous portions of the temporal bone: the mastoid hole is frequently in it; it nearly corresponds to the lateral sinus.

The *squamous suture* on each side is continued from the extremity of the sphenoidal, in an arched direction, upwards and backwards as far as the inferior angle of the parietal; it is then continued, under the name of *additamentum of the squamous suture,* directly backwards for about an inch. The structure of the squamous differs from that of the other sutures; the bones are not serrated, but are thin and scaly, and overlap each other; it unites the temporal to the parietal, but the additamentum is serrated, and connects the inferior angle of the parietal to the upper part of the mastoid portion of the temporal bone; it corresponds to a portion of the lateral sinus internally. A small os triquetrum is sometimes found at the anterior part of this suture, and seldom in any other situation, except in the lambdoid suture.

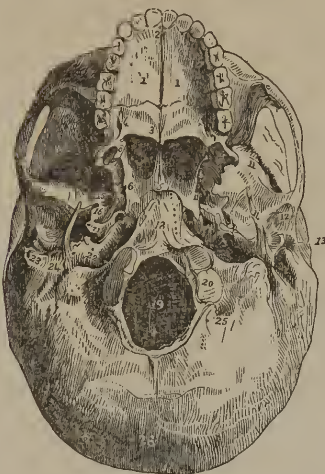
SECTION IV.

OF THE SKULL IN GENERAL.

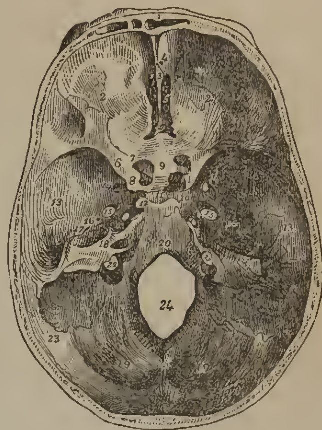
The *outer* surface of the skull presents four regions. The *superior*, or the vertex, is smooth and even, and has no remarkable appearance deserving more particular attention. The *lateral* regions are each divided into two, the anterior or temporal, and the posterior or mastoid; the meatus auditorius externus intervenes. The *inferior* region extends from the nasal notch, in the frontal bone, to the occipital protuberance, and is bounded laterally by the zygomatic arches and by a ridge, which is continued from these processes round the skull with but little interruption. This region may be divided into three portions, anterior, middle, and posterior. The *anterior* basilar region extends from the superciliary ridges of the frontal bone to the roots of the pterygoid processes of the sphenoid: it presents the nasal spine and process of the os frontis, the ethmoid bone, the orbital plates of the os frontis, bounded by their angular processes before, and by the orbital plates of the sphenoid behind. In this division are the supraorbital, the anterior and posterior orbital holes, the openings of the frontal and ethmoidal cells, the optic and lacerated holes of the orbits, the Vidian canals, and the foramina rotunda. The *middle* division extends from the roots of the pterygoid to the styloid processes of the temporal bones; it presents the azygos process of the sphenoid, the basilar process of the occipital, the anterior points of the petrous portions of the temporal bones, the spinous processes of the sphenoid, and the glenoid cavities of the temporal bones. The holes in this division are the oval, spinous, carotid, external auditory, and glenoidal; the Eustachian tubes are external to it. The *posterior* division extends from the styloid processes of the temporal to the tuberosity of the occipital bone; it presents the foramen magnum, the two condyles, the jugular ridges, the styloid processes of

the temporal bones, surrounded by the vaginal processes, the mastoid processes, the digastric grooves, the inferior and superior transverse arches, the spine, protuberance, and oppressions of the occipital bone. The foramina in this division are the stylo-mastoid, mastoid, magnum, lacera postica, anterior and posterior condyloid, aqueductus cochleæ, and the tympanic foramina in the petrous bone.

No. 99.*



No. 100.†



The skull is divided internally into the arch or vault, and the base. On the vault is to be observed the sulcus for the longitudinal sinus, the frontal crest, the grooves for the middle arteries of the dura mater, the depressions for the convolutions of the brain, and for the granulations or grandulæ Pacchioni. The base of the skull is very uneven, and presents on each side of the median line three regions or *fossæ* on different plans, viz., the *anterior* or *frontal*, the *middle* or *spheno-temporal*, and the *posterior* or *occipital*.

The *first* is formed of the orbital plates of the frontal bone, the cribriform

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* The inferior or external surface of the base of the skull. 1. The palate plate of the superior maxillary bone. 2. The foramen incisivum. 3. The palate process of the palate bone. 4. The posterior palatine foramen. 5. The vomer separating the openings of the posterior nares. 6. The internal pterygoid plate. 7. The external pterygoid plate. 8. The hamular process. 9. The pterygoid fossa. 10. The scaphoid fossa. 11. The zygomatic fossa. 12. The glenoid fossa. 13. The meatus auditorius externus. 14. The styloid process of the temporal bone. 15. The foramen ovale. 16. The foramen spinosum. 17. The foramen lacerum anterius basis cranii. 18. The basilar process of the occipital bone. 19. The foramen magnum. 20. One of the condyles of the occipital bone. 21. The carotid foramen. 22. The foramen lacerum posterius. 23. The mastoid process. 24. The stylo-mastoid foramen. 25. The posterior condyloid foramen. 26. The great protuberance of the occipital bone.

† The internal or cerebral surface of the base of the skull. 1. Frontal sinuses laid open. 2. The anterior fossa; the figure is placed on the orbital plate of the frontal bone. 3. The crista galli. 4. The foramen cæcum. 5. The cribriform lamella of the ethmoid bone. 6. The lesser wing of the sphenoid. 7. The foramen opticum. 8. The anterior clinoid process. 9. The middle clinoid process and olivary eminence. 10. The carotid groove. 11. The sella Turcica. 12. The posterior clinoid process. 13. The middle fossa of the base of the skull. 14. The foramen rotundum. 15. The foramen ovale. 16. The foramen spinosum. 17. The hiatus Fallopii. 18. The groove for the superior petrosal sinus. 19. The posterior fossa of the base of the skull. 20. The basilar process of the occipital bone. 21. The meatus auditorius internus. 22. The jugular foramen. 23. The groove for the lateral sinus. 24. The foramen magnum. 25. The ridge upon the occipital bone to which the falx cerebelli is attached.

plate of the ethmoid, and the lesser wings of the sphenoid. The foramina in this division are the cæcum, olfactory, internal orbital, and optic.

The *second* division is bounded before by the lesser wings of the sphenoid bone, on the sides by the squamous portions of the temporal, and behind by the superior angles of the petrous portions of the same bone, and by the posterior clinoid processes of the sphenoid. In the middle is the sella Turcica; on each side of which, but below it, is a groove for the carotid artery and for the cavernous sinus, and below this is a shallow groove for the superior maxillary nerve. Further out on each side are the cavities to lodge the middle lobes of the brain, and on the superior surface of the petrous bones are seen the juttings of the vertical semicircular canals. The foramina in this division are the foramina lacera orbitalia superiora, rotunda, ovalia, carotica, spinosa, lacera basis cranii anteriora, and innominata or hiatus Fallopii.

The *third* or occipital region is bounded before by the basilar process and by the posterior surface of the petrous bones, and behind by the occipital; it presents the basilar process, the foramen magnum, the perpendicular ridge of the occipital crossed by the transverse, by which this bone is divided into four fossæ. On the superior angle of each petrous bone is a shallow groove for the superior petrosal sinuses; the transverse occipital ridge presents a deep one for the lateral sinuses, which last are continued over the inferior angles of the parietal bones, and thence descend inwards along the mastoid portions of the temporal bones, and then again groove the occipital, and pass forwards on it to the posterior foramina lacera. The perpendicular ridge is grooved above for the longitudinal sinus, which terminates sometimes in the left, but more frequently in the right lateral sinus. The vertical ridge, below the tentorium, gives attachment to the falx minor, and is slightly grooved for the occipital sinuses. The foramina in this division are the foramina auditoria interna, aqueductus vestibulorum, foramina lacera postica, foramen magnum, foramina condyloidea antica and postica.

SECTION V.

THE BONES OF THE FACE.

The *face* is divided into the upper and lower jaw. The latter consists of but one bone, the inferior maxillary; the former is composed of thirteen bones, six pair and one single. The six pair are the malar, superior maxillary, lachrymal, nasal, palatine, and inferior spongy. The single bone is the vomer. These thirteen bones, however, are so intimately joined that the upper jaw might be regarded as a single bone, like the lower.

The *malar* or *cheek bone* is placed at the outer and under part of the orbit, and forms the prominence of the cheek. It is of an irregular square form; is very strong and compact, convex externally, and covered by the skin and orbicularis palpebrarum; it presents one or two small holes for vessels and nerves. Its upper and outer edge is named *external orbitar process*, and joins the frontal bone; its inner end, or the *maxillary process*, is cut off obliquely and serrated, and attached to and overlaps the maxillary bone. Its anterior edge between these two processes is round, smooth, and concave; it forms about one-third of the base or circumference of the orbit. Behind this the malar bone is smooth, and forms part of the temporal fossa; from its posterior surface a thin plate extends into the cavity, and is named *internal orbital process* or *plate;* this is notched posteriorly, and forms the anterior boundary of the spheno-maxillary fissure; this process is connected to the superior maxillary bone internally, and to the sphenoid bone externally. The lower edge is thick

and uneven, gives attachment to the masseter muscle, and it ends posteriorly in the *zygomatic process*, which passes backwards, and terminates in a serrated edge, which supports the zygomatic process of the temporal bone. The malar bone is thick, strong, and cellular; it is well developed in the fœtus: ossification commences early, and from one point. It is joined to four bones, the frontal, sphenoid, temporal, and superior maxillary. The processes are five, the superior, inferior, and internal orbital, the malar, and zygomatic. The foramina are two or three proper, and one common, viz., the spheno-maxillary fissure, or the foramen lacerum orbitale inferius.

The *superior maxillary bone* is of a very irregular figure, and attached to all the bones of the upper jaw; it forms the greater part of the front of the face, and a portion of the orbit, of the nose, and of the palate. It may be divided into the body and processes. The *body* is concave anteriorly, to form the infraorbital or canine fossa, in the upper part of which is the infraorbital hole. This fossa is bounded externally and above by a rough, serrated, triangular surface, the *malar process*, which is smooth and hollowed out behind for the temporal muscle. Springing from the inner and upper part of the body is the *nasal process*, of a pyramidal form, perforated by one or two small holes for vessels, serrated above to join the os frontis, prominent below, slightly grooved anteriorly to receive the nasal bone and the alar cartilage, and deeply grooved behind to form part of the lachrymal fossa and duct; its internal surface forms part of the nasal fossa, and is connected to the ethmoid bone above. Below this is a channel that leads to the middle meatus; and inferior to this is a crest for the inferior spongy bone. Between the nasal and malar processes is the *orbital plate*, of a triangular form, the base joined to the ethmoid, lachrymal, and palate bones. This process looks obliquely outwards and forwards: its outer and posterior edge bounds the spheno-maxillary fissure. The infraorbital canal, which runs along it in a direction forwards and inwards, lodges the vessels and nerves of that name. This canal divides anteriorly into two; the smaller is the *anterior dental*, which descends in the anterior wall of the antrum, where it terminates by communicating with the anterior alveoli; the other, or the proper *infraorbital canal*, is wider, and ends in the *infraorbital hole*. The edge of the bone above this hole is round, to form part of the contour of the orbit, behind which the inferior oblique muscle of the eye arises. Behind and below this plate is the *tuberosity*. This is more prominent in the young, as it contains the last molar tooth, after the protrusion of which it diminishes. Near this are three or four small holes, the *posterior dental canals*, which lead to the posterior alveoli. Beneath the orbital plate the body of the bone is excavated into a large cavity, the *antrum Highmorianum*, of a somewhat triangular figure, the base towards the nose, the apex towards the malar process. This is the largest sinus connected with the nose; it is sometimes divided by septa, as well as by the

Fig. 101.*

* The external surface of the superior maxillary bone. 1. The canine fossa. 2. The infraorbital hole. 3. The malar process. 4. The nasal process. 5. The groove which forms part of the lachrymal fossa and duct 6. The orbital plate. 7. The commencement of the infraorbital canal. 8. The tuberosity of the superior maxilla. 9. The nasal crest of the palatine process. 10. The nasal spine. 11. The concavity forming the lateral margin of the anterior nares. 12. The incisive or myrtiform fossa. 13. The alveolar process. 14. The two incisor teeth. 15. The canine tooth. 16. The two bicuspidati. 17. The three molares.

anterior dental canal, into two or more cells. The infraorbital canal runs along its roof; through the floor one or two of the molar alveoli project, and sometimes open; the canine fossa is in front of it, and the tuber bounds it behind. This cavity is lined by the membrane of the nose. In the skeleton the opening in its base is very large and irregular, but in the natural state it is contracted by the ethmoid and lachrymal bones above, by the palate bone behind, and by the inferior spongy bone below, also by the lining membrane of the nose; it opens by one or two small oblique openings into the middle meatus of the nose, anterior to which is the *infundibulum*, a deep groove leading from the frontal sinus and the anterior ethmoid cells downwards, backwards, and inwards, and opening into the middle meatus. The body of the bone is bounded below by a strong horizontal plate, the *palatine process*, the upper surface of which is smooth and concave, and forms the floor of the nose; the lower is rough, and forms the roof of the mouth, and is deeply grooved near the alveolar arch for the posterior palatine nerves and vessels: it is thick before, thin and serrated behind to join the palate bone; internally it is thick and rough, and joins the opposite bone by a suture, in the anterior part of which is the anterior palatine canal, which opens inferiorly on the palate by the *foramen incisivum*, and superiorly by two distinct holes, one in each nostril. This internal edge is raised so as to form the *nasal crest*, which, with that of the opposite side, receives the vomer. Anteriorly this projects so as to form the anterior *nasal spine*, to which the cartilaginous septum of the nose is attached. Between this and the nasal process the bone is very concave, and forms the anterior opening of the nares. Beneath the nasal spine, and above the incisor teeth, is a slight depression (*myrtiform*), in which the depressor labii superioris muscle arises; the prominent alveolus of the canine tooth separates the myrtiform from the canine fossa. The palate plate is bounded anteriorly and externally by the curved *alveolar edge* or *process*. This is very thick, particularly behind, and is divided into several, generally eight, conical cavities for the teeth: the partitions between these are formed of dense cellular texture, which is less compact posteriorly. The superior maxillary bone is connected to two bones of the cranium, the frontal and ethmoid, and seven bones of the face, the nasal, lachrymal, malar, palate, inferior spongy, vomer, and to its fellow of the opposite side, also to the teeth: it is sometimes connected to the pterygoid processes of the sphenoid. The processes are eight, the nasal, orbital, malar, tuberosity, alveolar, palatine, nasal crest, and nasal spine. The foramina are two proper and four common; the proper are the infraorbital and foramen incisivum. The common are the spheno-maxillary fissure, the foramen antri, the posterior palatine hole or canal, the anterior nares, and the nasal or lachrymal duct. This bone is of great transverse breadth, and is well developed in the fœtus, with the exception of the alveoli and sinus, the former commence about the end of the first year, the latter about the seventh, but a depression corresponding to it exists at birth. Ossification commences in the embryo at a very early age by four points: two in the orbital plate, one at each side of the infraorbital canal, one in the palate plate, and one in the incisor portion of the alveolar arch and anterior portion of the palate. This latter portion remains partly distinct from the rest of the bone for two or three years, and is rudimental of its permament state in many animals, in which it is named os incisivum or intermaxillare.

The *palate bone* is situated at the outer and back part of the nose, between the pterygoid processes and the superior maxillary bone. It is of a very irregular figure, and may be divided into four parts: first, the horizontal or palate plate; second, the nasal or perpendicular plate, at the lower and outer angle of which is, third, the pterygoid process; and, fourth, at the upper extremity of the nasal is the orbital portion. The *palate process* or plate is nearly square, flat, and rough below, smooth above, and concave from side to

side to form part of the floor of the nose. Posteriorly it has a thin edge, to which the velum palati is attached; its anterior border is serrated and cut off obliquely to join and rest upon the palate plate of the maxillary bone; its inner edge rises into a *crest* to support the vomer, and is continued posteriorly into the *posterior nasal spine*. Its centre is thinner than its edges. The *nasal process*, or vertical plate, is broad and thin; rises at right angles from the palatine; it rests partly on the maxillary bone. Its inner or nasal surface forms part of the nasal fossa, and is marked by two depressions, which assist in forming the lower and middle meatus of the nose: the ridge between these supports the lower spongy bone, and to that above the upper depression the middle spongy bone is attached. Externally it is uneven and grooved for the posterior palatine vessels and nerves. The anterior edge of this plate is thin and brittle, and prolonged for some way over the antrum; the posterior edge joins the pterygoid processes. The *tuberosity*, or the *pterygoid process*, arises from the lower and outer angle, is thick and wedge-shaped, inclines backwards, outwards, and downwards, and presents three fossæ, one at each side for each pterygoid plate, and one in the middle, which assists in forming the pterygoid fossa. The innermost of these fossæ is the deepest. This process is perforated by one or two small holes which lead from the palatine canal. At the upper extremity of the nasal plate are the *orbital* and *sphenoidal processes*, separated from each other by a deep notch. The *orbital* is the larger and anterior of the two; it is triangular, and bent a little outwards; it appears in the most remote part of the floor of the orbit, where it is joined to the maxillary bone by one edge, to the ethmoid and sphenoid by the second, while the third enters into the spheno-maxillary fissure. The sphenoidal or posterior orbital process is smaller, and is articulated to the body and spongy plate of the sphenoid bone, and assists in closing the sphenoid sinus. Both these processes are cellular; the cells communicate with those of the ethmoid and sphenoid bones. The notch between these two processes forms the spheno-palatine hole. The palate bone is joined to six bones, the maxillary, inferior spongy, vomer, sphenoid, and ethmoid, and to the opposite palate bone. It is composed of thin, compact substance, and is well formed in the fœtus. Its processes are seven: palate, nasal, pterygoid, orbital, sphenoidal, posterior nasal spine, and crest. Its foramina are one proper and three common. The proper is the posterior palatine hole or holes; the common are the posterior palatine or pterygo-maxillary canal, the spheno-maxillary fissure, or the foramen lacerum orbitale inferius, and the spheno-palatine hole; the latter is above the nasal plate, below the body of the sphenoid, and between the orbital and sphenoidal processes of the palate bone; it transmits the nasal nerve and artery from the spheno-maxillary fossa into the nose.

Fig. 102.*

The *inferior spongy* or *turbinated bone*, placed on the lower part of the outer side of the nose, elongated from before backwards, broad before, pointed or conical behind, presents a wrinkled or a rugged surface; is convex inwards, or towards the nose; concave outwards; its lower edge is loose,

* A posterior and internal view of the palate bone. 1. The superior surface of the horizontal or palate plate. 2. The internal surface of the nasal or perpendicular plate. 3. The pterygoid process. 4. The orbital process. 5. The spine or crest which articulates with the opposite bone and supports the vomer. 6. The posterior nasal spine. 7. The ridge which supports the lower spongy bone. 8. The depression which receives the internal pterygoid plate. 9. The depression which receives the external pterygoid plate. 10. The groove which assists in forming the pterygoid fossa. 11. The sphenoidal process. 12. The spheno-palatine hole.

spongy, and curled outwards; the upper edge is uneven, thin, and joined to the unguis and to the maxillary and palate bones. It is connected to the unguis by a thin *pyramidal process*, which completes the nasal duct; it is also in general united to the descending oblique process of the ethmoid. It is composed of very thin, brittle substance, marked with pores and little spines. It forms the floor of the middle and the roof of the lower meatus. Ossification commences from a central point: this is small in the fœtus. It is connected to four bones.

The *os unguis*, or *lachrymal bone*, is placed at the inner and forepart of the orbit, below the os frontis, behind the nasal process of the superior maxillary, and before the os planum; it is of an oval shape, and very thin: it covers the anterior ethmoidal cells. Externally it is divided by a perpendicular ridge, which terminates below in a little hook-like process into two unequal plates. The posterior or *orbital plate* is short and broad, and slightly concave; the anterior or *lachrymal plate* is very concave, long, and narrow, and forms part of the lachrymal or nasal fossa and duct. Its internal or nasal surface presents a vertical groove corresponding to the ridge on its orbital surface; its posterior portion is rough and slightly convex, and covers the anterior ethmoid cells: the anterior portion is very convex, and enters into the middle meatus. The os unguis is joined above to the internal angular and orbitar processes of the os frontis; behind to the os planum of the ethmoid, below to the orbitar plate of the maxillary, before to the nasal process of the same, and before and below to the inferior spongy bone; its structure is very thin, but very compact. Ossification commences early from a single point, and is complete at birth. It is joined to four bones.

The *nasal bones* are situated beneath the nasal process of the frontal and between the nasal processes of the superior maxillary bones; they are small and narrow, thick above, thin and expanded below: they form the bridge of the nose. The external surface of each is slightly concave from above downwards, convex from side to side, and perforated with one or two small holes; the internal surface is concave and grooved for the nasal nerves. The superior margin is thick and deeply denticulated, to join the nasal process and spine of the frontal and the nasal plate of the ethmoid bones. Its external edge is grooved, and joins the nasal process of the superior maxillary; its inner edge is flat, to join with its fellow, and both are a little grooved posteriorly; and its lower edge is very thin and irregular, joins the alar cartilages, and is notched for the passage of the nasal branches of the ophthalmic nerves It is composed of two compact plates, with intervening diploe above. Ossification begins in one point. It is joined to four bones.

The *vomer*.—This azygos bone resembles a ploughshare; it stands in the median line, although it often bends a little to one side; is thin and flat, and covered by the pituitary membrane. It presents four edges. The upper or sphenoidal, the thickest and shortest, is hollowed to receive the azygos process. The anterior is slightly grooved posteriorly, to receive the ethmoidal lamina; anteriorly it joins the nasal cartilage. The posterior or pharyngeal is sharp, smooth, and unattached, and separates the posterior nasal openings. The inferior or palatine edge is the longest, and is received between the laminæ of the nasal crest of the maxillary and palate bones; it is attached to the two maxillary, the two palate, the ethmoid, and sphenoid bones; also to the turbinated bones of the latter. Its structure is compact, but thin and transparent. Ossification commences from a single point, and in its lower portion; it appears at first as a groove or two lamellæ, between which the septal cartilage is lodged. Ossification advances from below upwards, and the lamellæ unite, except superiorly, where they receive the sphenoid and ethmoid azygos processes.

The *inferior maxillary bone*, or the lower jaw, is the largest of the facial

bones, of a semicircular figure, situated at the lower part of the face, and extending along its sides and back part to the base of the skull; it is divided into the body or chin, the sides, the rami, and the processes. The *body* is the anterior prominent portion, with a vertical ridge in the centre; the *symphysis*, or the line of union of the two symmetrical pieces of which in infancy it consisted. Inferiorly the body projects into the *mental process* or *chin*. Above this on each side is a depression for the muscles of the lower lip; external to which, and looking backwards, is the oval oblique opening of the dental canal, called the *mental hole*, through which a vessel and nerve of the same name pass. Posteriorly the body of the bone is concave, and lined above by the mucous membrane. In the middle it presents, in the line of the symphysis, a chain of eminences, to the superior of which the frænum linguæ adheres, to the middle the genio-hyo-glossi, and to the inferior the genio-hyoidæi muscles. Above and on each side of these are depressions for the sublingual glands, and at the lower border are two depressions for the digastric muscles. The *sides* of the maxilla have a direction backwards and outwards; on their outer surface is an oblique line, which passes backwards and upwards to the anterior edge of the coronoid process; it gives attachment before to the platysma and depressor anguli oris, and behind to the buccinator muscles. Internally, also, is an oblique line, parallel to, but more prominent than the external; to this is attached the mylo-hyoid muscle anteriorly, and the superior constrictor of the pharynx and intermaxillary ligament posteriorly. Beneath this *mylo-hyoid line* is a slight groove, which contains the mylo-hyoid nerve, and below this an oblong depression for the submaxillary gland. The lower edge or base of the jaw is rounded, thick before, thin behind, and grooved opposite the second molar tooth for the facial artery. The upper or alveolar edge is broad posteriorly, and bent a little inwards; it has usually sixteen alveoli, which, as in the upper jaw, vary in form according to that of the teeth. The *angle* of the jaw is nearly a right one in the adult, but in the fœtus is very obtuse; its margin is often a little everted; the masseter adheres to it externally, the internal pterygoid internally, and the stylo-maxillary ligament to the border of it. The *ramus* ascends in the adult nearly vertical, but a little backwards; in the child, and in the old or edentulous, it is very oblique: it is thick and round posteriorly, and enveloped by the parotid gland. Externally it is covered by the masseter muscle; internally by the internal pterygoid, above the insertion of which it presents a deep groove, which leads to a large hole, the *inferior dental* or *maxillary*. This is situated near the centre of the ramus, and is protected internally by a prominent spine, into which the internal lateral or tempora-maxillary ligament is inserted. A slight groove, containing the mylo-hyoid nerve and vessels, leads from this hole to the mylo-hyoid muscle. The dental hole leads into a canal which traverses the side of the bone beneath the alveoli, with each of which it communicates; it contains the dental nerve and vessels. Below the incisors this

Fig. 103.*

* The inferior maxillary bone. 1. The symphisis. 2. The side. 3. The ramus. 4. The mental process. 5. The mental foramen. 6. The external oblique ridge. 7. The internal oblique line. 8. The groove for the mylo-hyoid nerve. 9. The angle. 10. The inferior dental hole. 11. The coronoid process. 12. The condyle. 13. The sigmoid notch. 14. The alveolar process. 15. The four incisors. 16. The canine tooth. 17. The two bicuspides. 18. The three molares.

canal divides; one portion turns back a little, and ends at the mental hole; the other continues forwards beneath the incisor teeth. This canal is nearer the inner surface of the jaw behind, and the outer surface before. The ramus ends above in a notch and two processes, the anterior or coronoid, the posterior or condyloid. The *sigmoid notch* is traversed by the masseter nerve and vessels. The *coronoid process* is triangular; the apex is inclined a little outwards and backwards; it is embraced by the insertion of the temporal muscle, which descends lower on its internal surface. The root is grooved anteriorly for the attachment of the buccinator muscle. The *condyle* is an oblong, convex process, supported by a neck, which is most depressed anteriorly for the insertion of the external pterygoid muscle. The condyle is curved forwards, and most convex in that direction; its long axis is transverse, but is directed obliquely backwards and inwards, so that its internal extremity is posterior; it is also higher than the external: its posterior surface is nearly straight or flat, and almost free from cartilage. By these processes the lower maxilla is articulated with the temporal bones. On the external edge of each is a tubercle for the insertion of the external lateral ligament. The lower jaw in the fœtus always consists of two symmetrical pieces, which become united about the end of the first year. Each angle is very obtuse, and the condyles are directed more upwards than in the adult. Ossification occurs in it earlier than in any other part of the skeleton, even before the clavicle. In each lateral portion it commences by a central point; if examined in the embryo of five or six months an additional or separate point is also to be found in the inner part of the alveolar arch on each side.

As the teeth are intimately attached to the maxillary bones, and apparently are allied to the osseous more than to any other structure, their description and general anatomy may now be examined. They are not, however, to be considered as parts of the skeleton, inasmuch as they have not appeared in the very young, and are frequently absent in the very old; neither, critically speaking, do they constitute any portion of the osseous system, but rather appertain to the digestive apparatus, being the mechanical instruments employed in the prehension, separation, and mastication of the food, the incisors cutting and dividing it, the canine tearing it, and the molars bruising and grinding it. In man the teeth also assist in speech, certain articulate sounds (dental consonants) being produced by the point of the tongue striking against these bodies during expiration. In zoological science the teeth serve as an important element in the classification of the animal kingdom; their peculiar form and structure indicate the nature of the food on which the animal is to subsist; and as the digestive organs must be so modified as to convert the numerous varieties of nutriment into chyle, and as the limbs must be adapted for its prehension, so the teeth must bear an intimate relation to the entire organization, as well as to the habits of the animal.

Teeth differ from bone in many essential points. First, the greater portion of every fully-formed tooth is naked and exposed to the air, whereas all parts of a bone are invested by periosteum or by cartilage. Second, the central cavity in a tooth contains a vascular pulp instead of medulla. Third, the surface and intimate structure of a tooth are more compact, less vascular, and less organized, and with less of the animal and more of the mineral ingredients, than bone. Fourth, their diseases and powers of recovery differ from those of bone. Fifth, their duration is less than that of the general system, and they are changed or renewed once during life, the first set being temporary and deciduous, and succeeded by one which is permanent, but whose duration seldom equals that of the skeleton. Sixth, as to their development and growth. The matrix of a tooth is a vascular bulb or papilla inclosed in a membraneous sac, which at first is only a depressed follicle, a mere indentation or prolongation of the gastro-pulmonary mucous membrane, and hence

the stages of dental growth are distinguished by the terms papillary, follicular, and saccular, instead of, as in the case of bone, gelatinous, cartilaginous, and osseous. In order to acquire a knowledge of dental structure and development, the student should not only examine preparations in the museum, but also make careful dissections of the maxillary bones of the fœtus and infant at different ages. Although Hunter and Blake have ascertained many most important facts connected with these subjects, and the more modern writings of Purkinjie, Retzius, Muller, Goodsir, Nasmyth, and others, have added considerably to our knowledge, yet it must be admitted that dental anatomy is still, in many points, imperfect and uncertain.

We shall first consider the form and structure of the teeth.

The *teeth* are small, hard bones, thirty-two in number in the adult, sixteen in each jaw; their form is generally conical, the apex in the alveoli. In each tooth we distinguish the crown, neck, and root. The *crown* is external to the alveolus; it has no periosteum, but is covered by a firm, white, vitreous substance, named enamel. The *neck* is surrounded by the gum, and the *root* is firmly held in the alveolus by a mode of connection called *gomphosis;* it is covered by the periosteum, which lines the alveolus, and which is reflected upon it from the point to the neck. The root or fang of each tooth is perforated by a small hole for the nutrient nerve and vessels. The teeth are divided into three classes, the incisores, the canini, and the molares.

The *incisores* are four in each jaw. The crown of these is sharp and wedge-shaped, convex before, and thickly covered with enamel. The neck is constricted, and the root is conical, but flattened upon each side. Those in the upper are stronger and larger than those in the lower jaw; the former are broader; their edge is like a chisel, cut off posteriorly; the latter are more vertical, and bevelled off anteriorly; they are not so sharp as those in the upper jaw; their roots are larger. The middle incisors in the upper jaw are much larger than the lateral, but in the lower the lateral are a littl› larger than the middle.

The *canine teeth*, or *cuspidati*, are two in each jaw, or one on each side of the lateral incisors. The crown is conical, a little blunt, convex before; their root is single, but very long, and larger than those of the incisors, flattened at the sides, and grooved. Their alveoli are often very prominent.

The *grinders*, or *molares*, are twenty in number, ten in each jaw. The crown of these is broad and irregular; the roots are more or less divided. The two first molar on each side in each jaw are called *bicuspidati*, and are of an intermediate size between the canine and posterior molars. They have only two tubercles on the crown, which is rather round. The fangs in some are single, but usually double; the lower are smaller than the upper, and the tubercles on the crowns are not so deeply separated. The first lower bicuspid frequently wants the inner tubercle, and resembles a canine. The posterior grinders are the true molar or *multicuspidati*, three on each side in each jaw. These are large; the crown is somewhat square, has four, and sometimes five tubercles; the neck is thick and round; the root has three or four divisions, and each is perforated by a small hole. The crowns of the lower are rather larger than those of the upper; the latter are vertical, but the former are inclined a little inwards. The fangs of the lower are usually two, but very broad and strong, placed anteriorly and posteriorly, often much curved, flattened before and behind, grooved, and often bifid. The first and second upper have usually three roots, one internal, two external; sometimes they have four. The first molar is generally the largest; the last, or dens sapientiæ, is the smallest; its crown is short, and has only three tubercles, two external and one internal. The root, though often single, is grooved, and sometimes presents three partial divisions in the upper and two in the lower. These last teeth, however, are very variable as to size and other

characters, and occasionally even are not protruded, particularly in the upper jaw.

Every tooth, when divided, presents an external shell or cortex, and an internal cavity which extends beneath the crown, partly corresponding to it in form, contracts as it descends through the root into a fine tube, which ends in a minute foramen. In the young and growing tooth this cavity is large, and contains a soft, vascular pulp or bulb; in the course of time it is much diminished by surrounding osseous or ivory deposit, and in the adult or aged contains little more than a vascular lining membrane. The parietes of this cavity, though very firm, are perforated by numerous minute pores, which lead into the solid texture of the tooth. The substance of a tooth consists of three elements: enamel, ivory or dentine, and crusta petrosa or cement. The enamel covers the crown; the ivory forms the greater portion of the body and root; and the crusta, in the form of a thin lamina, invests the root only, though, according to Nasmyth, it is also prolonged over the crown and enamel. In the compound teeth of the herbivora this ingredient enters largely into their composition, forming with the enamel vertical plaits, which alternate with plaits of ivory or dentine, and present their margins to the grinding surface, which is thereby always retained in a rough state, as the three substances wear unequally, the enamel being the hardest, and the crusta the softest.

Enamel covers only the exposed portion of the tooth, is thickest on the most prominent parts of the crown, that is, on the cutting edges and grinding points; it becomes thin towards the neck, where it ends in an abrupt line within the margin of the gum. It is of a milk-white color, extremely hard and brittle, can strike fire with steel, resists the file or saw, and is, therefore, peculiarly well adapted to withstand friction and pressure: heat soon renders it friable, and after a long time blackens it; whereas this latter change soon occurs in ivory, as it contains much more of an animal basis. If, therefore, a section of a tooth be exposed for a short time only to a stron . clear heat, the blackened ivory and the unchanged enamel become separated by a well marked line of distinction. It is composed of minute fibres or prisms, arranged in close parallel lines, marked with fine transverse striæ, placed perpendicular to the ivory, to which they are intimately attached. A delicate membrane is said by some to intervene, and to be demonstrable after maceration in a dilute acid. In a longitudinal section the fibres become apparent, taking a wavy, but still a parallel course, and under magnifying powers appear to be composed of minute, hexagonal, crystalline cells, connected in a linear order, and filled with calcareous substance. When enamel has been steeped in dilute acid, the salts are removed, and a very small portion of delicate animal tissue remains, the membraneous cells in which the mineral matter had been contained. The chemical composition of enamel is, in 100 parts: phosphate of lime, 85.3; fluate of lime, 3.2; carbonate of lime, 8; phosphate of magnesia, 1.5; membraneous matter, water, and soda, 2. This preponderance of the earthy materials accounts for the durability of the enamel during life, as well as for its almost imperishable character in animal remains.

Ivory or *dental bone*, or *dentine*, is the chief constituent of a tooth; is of a yellowish white color; its fracture presents a soft, silky, fibrous appearance. Though not so hard as enamel, it is much harder and closer in texture than bone. At first view it appears a homogeneous solid, but, if examined in a young tooth, or when steeped in weak acid, it presents a fibrous and reticular texture, and under high magnifying powers the fibres are found to be minute tubuli, arranged in a different order from those of the enamel. These tubes commence in the walls of the cavity, which are cribriform, and take a serpentine and radiating course towards the surface, or towards the enamel, subdividing and ramifying with great minuteness, the interstices being filled with

fibrous substance, on which the ivory is deposited in lines parallel to the tubes; and the tubes themselves contain small, opaque bodies, supposed to be the nuclei of the ivory cells. Retzius has delineated these tubes in a very beautiful manner, and described them as dividing soon after they leave the central cavity in a dichotomous manner, and also giving off numerous fine offsets, some of which anastomose, and some can be traced into small cells, like those in bone, thus presenting a close analogy, in the elementary structure, of dentine and true bone. He has also observed, that the arrangement of these tubes differs in different classes of animals. The chemical composition of ivory or dental bone is, in 100 parts: phosphate of lime. 61.95; fluate of lime, 2.10; carbonate of lime, 5.30; phosphate of magnesia, 1.25; soda and chloride of sodium, 1.40; cartilage and water, 28.

Crusta petrosa, or *cement*, is a thin, osseous lamina, coating each root or fang from its point to the enamel at the neck. It is thin in the young, but increases in thickness in the aged, and sometimes even forms an exostosis on the roots, and partly fills up the cavity in the fang and in the body of the tooth. It is not so vascular as bone, but resembles it in other respects, containg the same anastomosing tubuli and calcigerous corpuscles. The minute tubes and cells in this substance communicate with those in the dentine; accordingly, when the pulp has disappeared, or if the central cavity be wholly obliterated, the dental tubes may receive a supply of fluids from without, that is, from the crusta petrosa, which derives its vessels from the periosteum. In the compound teeth of the herbivora it is very abundant, filling up the interstices between their different crowns or divisions.

Although no vessels can be seen permeating this dental structure, yet it cannot be wholly extravascular or inorganic; most probably the minute tubuli absorb some fluid from the pulp in the central cavity, and circulate it through the general tissue. In young animals fed on madder the dentine becomes colored, like the rest of the osseous system; and even in old animals the same change of color will occur if this food be long continued. In jaundice also, of long duration, the teeth have sometimes acquired a yellowish tint; and occasionally these bodies show some power in repairing the effects of disease, a new lamina of crusta, or even of ivory, being sometimes thrown out upon a carious surface.

The *dental pulp, papilla*, or *bulb*, is of the same form as the cavity which incloses it. It consists of a delicate, soft, membraneous, recticular texture, very vascular and sensitive. The vessel which supplies it is a small branch of the dental artery; it enters the canal in the fang, and forms a capillary network on the pulp; the nerve accompanies the artery, and is derived from the dental branch of the superior or inferior maxillary nerve. The reticular tissue of the pulp is described by Mr. Nasmyth as consisting of a congeries of nucleated cells, in which the calcareous salts are deposited from the blood, and which are converted into ivory upon the surface, and as one set of cells is removed another set is produced from the capillary network. The pulp is larger in the very young tooth than subsequently, and, together with the dental capsule, is mainly concerned in those processes of development and growth which we shall next consider.

The development of the teeth commences at a very early period of intrauterine life. According to the researches of Goodsir (Edinburgh Med. and Surg. Jour., Jan., 1839), the process may be divided into four stages, the papillary, follicular, saccular, and eruptive. The rudiments of these organs have been observed by him in an embryo of the sixth week, whose weight was only fifteen grains, and length little more than half an inch. He states that about the sixth week the upper maxillary bone presents a deep, narrow groove within the external alveolar margin; this is the *primitive dental groove*, and is lined by the mucous membrane. About the seventh week a small

papilla appears on its floor, near its posterior part; this is the germ of the anterior deciduous molar. In the eighth week that for the canine, and in the tenth those for the incisors appear, and, next, that for the posterior deciduous molar. This is the *papillary stage*, and is followed by the *follicular*, which is not completed until the fourth or fifth month; this is effected by delicate processes, extending from the sides of the dental grooves over each papilla, and meeting before and behind it, so as to inclose it in an open follicle. The first is formed around the anterior molar, and the rest soon follow. The papillæ now begin to change their form, and to assume that of the future teeth. The follicles next become closed by small membraneous processes, extending from their edges across the openings. The incisors have two of these opercula, the canine three, and the molars four or five. When these opercula have adhered to the margins of the follicles, the latter are converted into sacs, and the *saccular stage* commences; this continues from about the fourth month to the completion and eruption of the teeth, which occur at different periods of infantile life; the incisors about the seventh or eighth month after birth, the canine and bicuspides still later, and the last molar or wisdom tooth not until the twentieth year. It is during the saccular stage that the most important and interesting phenomena in dental growth occur, namely, the enlargement of the papilla into a pulp or bulb, the formation of the dentine and enamel, the changes in the maxillary bones, and the ossification of the alveolar processes.

Soon after the commencement of the saccular stage of the deciduous teeth, the rudiments of the second or permanent set are developed. About the fourteenth week the deep portion of the primitive dental groove is closed in, and contains the sacs and papillæ of the ten milk teeth; the upper or superficial portion of the groove remains open, and is now named *secondary dental groove.* In this commence the rudiments of the permanent teeth. At first a small crescentic depression is observable behind the opercula of the milk sacs; this increases, and forms the *cavity of reserve.* These cavities are lined by an inflection of the mucous membrane, and at the bottom of each a small papilla is formed; they gradually recede from the surface, and are thereby converted into follicles, and finally into closed sacs, which lie to the inner side and in close contact with the former set, and inclosed in the same submucous tissue. The necks of these sacs, by which they originally communicated with the general mucous membrane, continue as obliterated cords leading to the surface of the gum, internal to the deciduous teeth. These cords have been named the *gubernacula*, or itinera dentium; from which, however, we are not to infer that these cords answer any such office as their name would imply. The primitive dental groove, behind the posterior deciduous molar, does not close so soon as the anterior portion, and in it are developed about the fifth month the follicle and papilla of the anterior permanent molar. After its follicle has closed, the dental groove closes over it, leaving a space between the gum and the sac of this tooth; in this is a cavity of reserve of mucous membrane for the second permanent molar, and one also for the third or the wisdom tooth. As the deciduous sacs, as well as the anterior permanent ones, increase in size more rapidly than the bones can elongate, this cavity for the permanent molars is pressed backwards into the maxillary tuberosity above, and into the root of the coronoid process below; but in a few months after birth, as the jaws increase in size and length, the first permanent molar returns to its proper level in the dental range, the cavity of reserve behind then dilates into the space the first molar occupied, and in it is developed the papilla for the second permanent molar. In the course of time, as the jaws further elongate, this tooth advances and descends, and the remainder of the cavity of reserve dilates behind for the third permanent molar or wisdom tooth. Before we allude to the fourth, or the eruptive

stage of either set of teeth, we have to consider the mode of growth of these bodies in the dental sacs. As soon as the pulps assume the shape of the future teeth, they form upon their surface the ivory or dental bone; this process commences about the fourth or fifth month of intra-uterine life, and the ivory is deposited on the most prominent points of the teeth, that is, upon the cutting edges and grinding points. The number of points on each tooth is variable; on the incisors there are three, on the canine one, on the bicuspides two, and on the molars four or five points. In the fœtus at birth, and for some time previous to it, the border of each maxillary bone presents a groove or channel, covered by a dense and whitish fibrous tissue, adhering to and continuous with the gum on either side. On raising this we find imperfect bony and membraneous septa between the alveoli, and into each of the latter a prolongation from this fibrous lamina extends, inclosing each dental follicle in a distinct sac, which is perforated at the bottom for the passage of the nutrient vessels and nerves. If any one of these dental bags be examined, it will be found to resemble a serous sac, and to contain a little fluid. The external or parietal layer is fibro-cellular, lines the alveolar depression, is connected to its periosteum, and is reflected from the bottom of it, around the vessels and nerves, over the pulp, on which it forms the tunica propria, and which is highly vascular. This lamina was originally, that is, in the follicular stage, mucous membrane; the pulp itself rises from the fundus of the sac where the vessels enter, and caries before it this vascular tunica propria. On the surface of the pulp the ivory or dental bone is deposited; the more superficial of the nucleated cells which it contains become elongated, and are disposed vertically on the surface; and as these become calcified those beneath become similarly arranged, and so on, until the tooth acquires considerable thickness, and the greater part of the pulp is ossified. The process commences in points or spots varying in number in the different teeth; in the molars by four or five, in the bicuspides by two, in the canine by one, and in the incisors by two or three. All these points increase in size and thickness, and coalesce so as to form a deep hollow shell, the extreme margin of which is thin and elastic, like horn, but the centre is thick and stratified, the inner laminæ being the last formed and the longest, as they extend to the root or fang. This shell incloses the pulp all around, except on its under surface, where the vessel and nerve enter it; it then begins to contract around the future neck and fang, and, as the latter elongates, the whole mass appears to rise towards the gum; at first there is no process of the pulp answering to the root, but as the cavity of the tooth is diminished the pulp is elongated, and sinks into the alveolus, and continues to deposit the dentine around it; the alveolus now contracts, and grasps the neck and commencing root, and adheres to the latter through the investing membrane; an alveolar edge gradually rises up along with the tooth, so that the latter does not really sink so much into the bone as it appears to do. If more than one root is to be formed, the opposite margins of the ivory shell extend across the pulp, meet in the middle, and divide the cavity into two or more openings or tubes, through each of which portions of the pulp extend, and around each ivory is produced. During this process the dental sacs are large, and contain a quantity of granular matter, which is gradually absorbed; and when the ivory shell is formed, the interior of the parietal layer of the dental sac has a villous and vascular appearance, like mucous membrane, with a thin layer of granular matter upon it, which may be considered as a sort of epithelium lining the interior of the opercula of the original follicles. This surface, therefore, is the matrix of the enamel, or is the enamel organ, and it is impossible that this substance can be produced from the pulp, or from its vessels, as the former is now enveloped in the ivory shell. The enamel, therefore, is produced by the calcification of the nucleated prismatic cells contained in the granular epithelium

lining the opercula of the dental sacs; it is deposited at first, and in greater quantity, upon the most prominent points of the tooth, but soon forms a coating all over the crown, and around the body, as far as the neck, where it is thin and ends abruptly, there being none upon the fang, as there the outer wall of the sac has become adherent to the root, and of course leaves no space for enamel deposit. The enamel appears to be deposited upon the ivory in minute crystalline, calcareous particles, at first not very hard or compact, but these soon solidify and adhere most intimately to the ivory, abutting on its surface, its fibres or prisms being in a different direction to that of the dental tubes and fibres. According to some a delicate membrane can be detected between the ivory and enamel in a tooth some time steeped in dilute acid; and Purkinjie conceives that the ivory is deposited between the pulp and its investing capsule, while the enamel is formed external to the latter by the enamel organ.

The *crusta petrosa*, or cement, forms a thin coating around the root or fang, and is formed by the lower or alveolar portion of the dental sac, which invests and adheres to the root, and is converted into this substance. According to Nasmyth (Med. Chir. Trans., vol. xx.), the inner layer of the upper portion of this capsule remains adherent to the crown, and forms upon the enamel a thin coating of crusta, which, however, is soon worn off.

The *eruptive stage* commences when these several parts of the tooth are completed, and appears to result partly from the elongation of the fang causing the elevation of the tooth, and partly from the absorption of the superincumbent structure, which at last gives way at some small point; the tooth then protrudes, and the sac again assumes its open or original follicular form. This opening encircles the neck of the tooth, and forms a closely fitting collar around it, and is continuous externally with the gum. The protrusion of the tooth rapidly increases, and more so than can be ascribed to the elongation of the fang mechanically raising it, by pressing against the bottom of the alveolus; on the contrary, indeed, there is an interval left beneath the root to admit of its growth and completion, and, therefore, the elevation of the tooth would appear to depend partly on a shortening or contraction of the dental sac. Prior to the eruption of the milk teeth, the septa between them have become ossified, and perfect alveoli have been formed. During this period, also, the sacs of the ten anterior permanent teeth, which at first were connected to the submucous tissue of the deciduous sacs, have been retiring in an opposite direction, and sinking deeper in the bone, and become inclosed in osseous cells, which gradually extend beneath the fangs of the temporary teeth, and are separated from them by their distinct alveoli; and the fibrous cords extend from the necks of the temporary sacs along the sides of the alveoli to the surface of the gum. The permanent sacs at first receive their vessels from those of the gum, but afterwards from the temporary sacs; and as they retire into their own cells these new vessels enter into new dental canals, which become permanent. In the course of a few years, and after all the temporary teeth have appeared, the further elongation of the jaws admits of space for the first true molar to protrude; this usually occurs between the seventh and eighth year. At this age there are fifty-two teeth in the head, viz.: twenty deciduous, twenty permanent beneath these, and the twelve posterior molars: and when all the anterior permanent teeth have become enlarged they press upon the anterior wall of their alveoli, which soon undergo absorption, and then each tooth comes a little forwards into the lower part of the alveolus of the milk tooth; the fangs of the latter are absorbed and gradually wholly removed, and then the crown falls out of the sac, and the permanent tooth supplies its place. The absorption of the milk root, however, is not to be attributed wholly to the pressure of the permanent tooth against it, for it often occurs long before the permanent tooth has en-

tered its alveolus. Neither the deciduous nor permanent teeth appear at perfectly regular periods. The four central incisors usually protrude about seven or eight months after birth; those of the lower jaw first: the lateral incisors follow about the ninth or tenth month; about a year or a year and a half the anterior molars, and then the canine; between the second and third year the posterior molars appear. There is no certain rule as to the priority of those of the upper and lower jaw, except in respect to the incisors, and ir general the development on each side proceeds *pari passu.* About the seventh year, as was before mentioned, the first permanent molar appears, nearly about the time when the first incisors are replaced by the permanent. After all the incisors are changed, the anterior and posterior temporary molars are successively shed and replaced by the permanent bicuspides; the canines are not changed before the tenth or eleventh year. About the twelfth or thirteenth, the second permanent molars appear; and the last, or dentes sapientiæ, seldom before eighteen or twenty, but occasionally at a much later period.

SECTION VI.

THE THORAX OR CHEST

Is formed posteriorly by the twelve dorsal vertebræ, already described, laterally by the twelve pairs of ribs, and anteriorly by the costal cartilages and sternum.

Fig. 104.*

Fig. 105.†

The *sternum* is situated at the forepart of the thorax, in the median line, and in an oblique direction from above downwards and forwards, its superior end being much nearer to the spine than its inferior; flat and elongated, broad and thick above, narrow in the middle, and thin and pointed below; its average length is six inches, and a little more in the male than in the female: it has been resembled to a sword, the upper piece named manubrium or handle, the middle gladiolus, and the lower extremity ensiform or xiphoid cartilage. Although it can often be separated in the adult into these three pieces, we shall first describe it as one bone. Its *anterior surface,* flat or slightly convex, is covered by the skin, and gives attachment to the pectoral aponeurosis and to the tendons of the sterno-mastoid muscles, and is marked by transverse lines, which indicate its original division into six pieces. Of these lines the two uppermost, especially the first, are the most prominent. Its *posterior* surface is smooth and slightly concave, covered by a thick and glistening periosteum, and marked by transverse lines correspond-

* The posterior surface of the sternum. 1. The posterior surface of the first piece of the sternum which gives attachment to the sterno-hyoid and sterno-thyroid muscles. 2. The second piece of the sternum, giving attachment inferiorly to the triangularis sterni or sterno costalis muscle. 3. The posterior surface of the xiphoid cartilage or appendix, to which the anterior fibres of the diaphragm are attached.

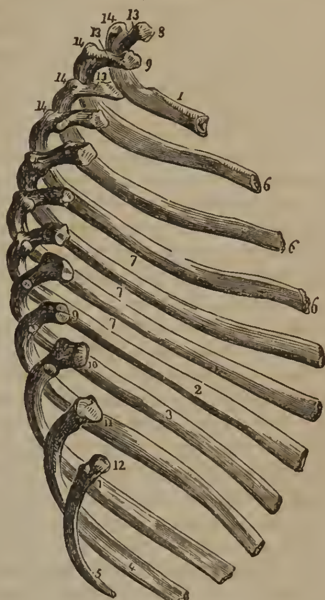
† The anterior surface of the sternum. 1. The upper piece of the sternum. 2. The middle piece. 3. The xiphoid appendix, or ensiform cartilage. 4 An oblique surface for articulation with the clavicle. 5. The notch which receives the cartilage of the first rib. 6. The notch formed partly by the first and partly by the second piece of the sternum for articulation with the cartilage of the second rib. 7. The depression for the cartilage of the third rib. 8, 9, 10. 11. Depressions which receive the cartilages of the fourth, fifth, sixth, and seventh true ribs.

ing to, but less prominent than those in front: the sterno-hyoid and thyroid and triangulares sterni muscles are attached to this surface; the pericardium also has a cellular connection to it. The *superior* or *cervical end* is thick and broad, and very concave transversely. This semilunar concavity or notch corresponds to the root of the neck, and is occupied by the interclavicular ligament; at each angle of it is the articular cavity for the clavicle, covered with cartilage, and directed outwards and backwards, slightly covex from before backwards, and concave from within outwards. The *inferior* or *abdominal end*, or *xiphoid process*, is the smallest portion, thin, and usually cartilaginous in part; is very variable as to form and size, sometimes pointed, sometimes bifid, thick or thin, turned forwards or backwards, and sometimes perforated by a central hole. To it are attached the linea alba, the abdominal aponeurosis, and the costo-xiphoid ligaments. The *sides* or *lateral edges* of the sternum are thick and uneven, marked by the articular depressions for the seven costal cartilages, and by intervening semilunar notches. The superior depression is shallow, and immediately beneath the clavicular surface; its edges are often continuous with the first costal cartilage: the remaining depressions are angular and deep, and correspond to the transverse lines; hence these sockets are more distinct in the young than in the old; they are all covered with cartilage, and separated by semilunar notches, which are larger above than below, as the inferior cartilages are closer to each other than the superior.

Ossification commences rather late in the sternum, and proceeds slowly and variably: a cartilage of the same form exists in the embryo of the fourth or fifth month, and ossific development occurs at least in six different parts. In the manubrium, it commences about the fifth month, in one central or in two lateral or symmetrical nuclei, which soon unite. In the body or middle portion there are four central nuclei, but sometimes double; these ossific points are nearly opposite the costal cartilages. The ossification of the xiphoid appendix seldom occurs before three or four years; it commences in its upper part, and slowly extends downwards. These six pieces do not unite for many years. The four divisions of the middle portion are joined together about twenty-four years of age; the fourth and third first join, then the second joins the third, and, lastly, the first joins the second. The xiphoid appendix is seldom ossified to the middle portion before the fortieth year, and the body and manubrium are never wholly united until old age, and even then seldom completely so. Of the three pieces into which the adult bone can be separated, the first, or the manubrium, presents the clavicular articulating surface on each side, also the socket for the first, and half the socket for the second costal cartilage; the second portion, or gladiolus, presents on either side six notches, one to complete the socket for the second cartilage, one for each of the four following, and half a one for the seventh, the remainder being made up by the xiphoid appendix. A foramen often exists in the lower part of the middle division, of very variable size; it is closed by membrane, and is probably the result of some arrest in development. Two small osseous appendices are occasionally found in the fully developed sternum, one at each side of and behind the semilunar notch in the upper border of the manubrium. They have been named *presternal* or *suprasternal points*, and are regarded by some as the sternal ends of non-developed cervical ribs, and by others as the analogue of the fourchette bone in birds. The sternum is articulated to sixteen bones, viz., the clavicles and the seven true ribs of each side; it is maintained in its situation wholly by the latter, and its upper end supports the clavicles and the superior extremities; it completes the anterior wall of the thorax, and affords immediate protection to the heart. It consists of a spongy, vascular diploe, invested on each surface by a lamina of compact tissue. Its nutrient vessels enter numerous foramina in its posterior surface.

The *ribs* are twelve on each side; they extend in an arched manner from the vertebræ towards the sternum, to which the seven superior are attached by separate cartilages; these are the *true* or the *vertebro-sternal ribs*. The five inferior, with their cartilages, do not reach the sternum, but are connected anteriorly to each other, and to the cartilage of the last true rib, and are named *false* or *vertebro-costal*, or *asternal*. The two last of these are sometimes called *floating* or *vertebral* ribs. The length of the ribs gradually increases from the first to the eighth, and then diminishes to the last; the breadth gradually diminishes from the first to the twelfth, but in each rib, except the two last, it is greatest near the sternum. The first rib is nearly horizontal, the succeeding gradually incline downwards, so as to be lower before than behind. The *external surface* of the *body* or shaft is convex and smooth, and gives attachment to different muscles; the internal is concave, and lined by the pleura. The *upper border* is round and smooth, and gives attachment to the intercostal muscles. The *inferior* forms a wider curve than the superior, is thin, and marked with a groove on its inner side; deep posteriorly, and superficial anteriorly; its edges give attachment to the intercostal muscles; posteriorly it lodges the intercostal vessels; it disappears anteriorly. The *posterior end* of a rib presents a head, neck, and tuberosity. The *head* is round, and divided by a ridge into two articular surfaces, the inferior of which is the larger; these are received into the depressions in the dorsal vertebræ: an interarticular ligament is attached to the middle ridge. The head is supported by the *neck*, which is thick, round, and strong, and lies in front of the transverse process, to which its posterior surface is connected by the middle costo-transverse ligament. On its upper border is a ridge or crest, to which the anterior or internal costo-transverse ligament is attached. Beyond or external to the neck is the *tubercle*, which looks backwards and downwards, and is divided into two portions. The internal is smooth for articulation with the transverse process of the inferior of the two vertebræ, to whose bodies the head of the rib is connected. The external is rough, for the insertion of the external costo-transverse ligament. External to the tubercle, and on the posterior surface, is a rough line, which marks the turn or *angle* of the rib. This ridge gives insertion to the tendon of the sacro-lumbalis muscle; it descends obliquely forwards; it is close to the tubercle on the first, but the distance between these increases in the succeeding ribs to the eleventh; the angle is not distinct on the twelfth. That portion of the rib behind or inter-

Fig. 106.*



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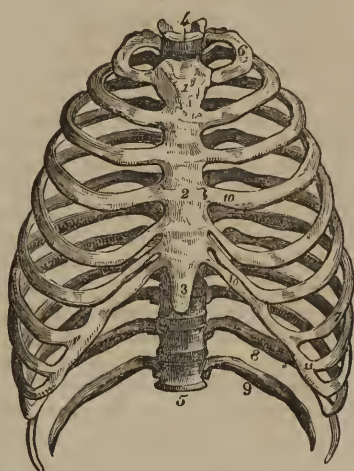
* View of the internal surface of the ribs. 1. The first true rib. 2. The seventh or last true rib. 3. The eighth or first false rib. 4 and 5. The eleventh and twelfth or floating ribs. 6. The anterior extremity of the rib. 7. The inferior margin of the rib, grooved internally for the intercostal vessels and nerve. 8. The head of the first rib, presenting a single articular surface. 9. Heads of the ribs from the second to the ninth inclusive, presenting two articular facettes, separated from each other by a ridge. 10,11,12. The heads of the tenth, eleventh, and twelfth ribs, each presenting a single articular surface. 13. The neck of the rib. 14. The tubercle of the rib.

nal to the angle is the strongest and thickest: at this point the bone is curved in two directions, the posterior or vertebral portion being directed inwards and a little forwards, while the shaft is directed forwards and outwards; the apex of this angle of curvature is directed backwards and outwards; by the other curvature the anterior part or the shaft of the rib is bent downwards, and forms with the posterior or higher portion an obtuse angle, convex downwards; hence, when the lower edge of a rib is placed on a horizontal surface, only the anterior portion remains in contact with it; all that part behind the angle rises above it. At the angle the rib also presents a twisted appearance, so that the outer surface of the vertebral portion has an aspect downwards and backwards, while that of the shaft looks upwards and outwards. The outer surface of the shaft presents near its anterior extremity an oblique line for the attachment of muscles; this line is sometimes named *anterior angle.* The anterior or *sternal end* is thick, spongy, flattened, and hollowed into an oval pit for the insertion of the costal cartilage.

The *first rib* is short, broad, and strong, and nearer the axis of the chest than the others; has no angle, and is not twisted, but represents nearly a horizontal semicircle. Its external surface is directed upwards, and is marked by two grooves for the subclavian vein and artery; into the intervening ridge the anterior scalenus muscle is inserted. The head of this rib is undivided; the neck is long and round; the tubercle very prominent; the shaft has no groove on its inferior or external border; the internal edge is concave; the sternal end is very strong. The second rib partly resembles the first; it is, however, much longer, and forms a wider curve; it has very little angle or torsion; its external surface looks partly upwards, and presents near its centre a rough ridge for the attachment of the serratus magnus muscle: its inner surface is directed partly downwards, and presents a short groove posteriorly. The tenth rib has sometimes but one articular surface at its head to join the tenth dorsal vertebra. The eleventh and twelfth also have each but one articular surface on the head; they have neither tubercle, angle, nor groove; they are short and thin, and pointed anteriorly. The ribs are formed of a cellular structure, covered by a compact and strong lamina, which often presents a scaly appearance; in form they resemble the long bones, but in tissue the flat or irregular. In the young the cancellated structure prevails, but in the old the compact; hence in the former they are more resisting and elastic, and in the latter more brittle, and, therefore, more liable to fracture. The nutrient arteries enter the bones on their inner or pleural surface, and their canals uniformly are directed obliquely backwards in the shafts, although the intercostal arteries are running forwards, but in the vertebral extremities the vessels pursue irregular and variable directions. Ossification commences in the ribs at a very early period of uterine life, even in the second month, and rather sooner than in the vertebræ: there are three points of ossification, one for the head, another for the tubercle, and the third for the body or shaft; the latter is the primitive and the principal one, the two former are epiphyses, and do not appear till the fifteenth year, and are not joined to the rest of the bone until the twenty fifth. The two last ribs want these epiphyses. In the fœtus the ribs are straight, their posterior curvature less developed; their shafts continue forward more in a direct line, and do not slant downwards, as in the adult; their angles do not project posteriorly so as to enlarge the thorax in that direction, and, therefore, the lungs do not extend into those hollows on either side of the spine which become subsequently developed. In some cases there are thirteen ribs on one or both sides; these supernumerary bones being developed either from the anterior transverse process of the last cervical, or of the first lumbar vertebra. More rarely there is a deficiency in the number; in such a case the first rib may be only rudimental, or two adjacent ribs may be united together.

The *costal cartilages* must be considered as part of the skeleton of the thorax; they are of the permanent class, and are twelve in number, and of nearly the same form as the shafts of the ribs, which they serve to prolong anteriorly, and, being extremely elastic, contribute to the general functions of the cavity. The costal end of each is broader than the sternal; the former is convex, and received into the depression in the end of the rib; the latter, also convex, into the angular fossa, on the border of the sternum. Their anterior surface is flat or slightly convex, covered by and attached to the great pectoral muscle. Their posterior surface is amooth and concave, and partly lined by pleura. Their margins bound the intercostal spaces, and give attachment to the internal lamina of intercostal muscles. The first is very broad, but short; the length increases in the succeeding to the seventh, and then decreases to the last: the first descends a little, the second is nearly horizontal, the succeeding ascend more and more. Those of the three superior false are blended together, and those of the two last are short, pointed, and unattached, except to the abdominal parietes. The costal cartilages are the strongest and longest in the body; they are flexible and elastic, and have a great tendency, particularly the four or five superior, to ossification; the costal end is more prone to this change than the sternal; they then become opaque and very compact. In their natural state they appear destitute of vessels, nerves, or any organic texture, but are enveloped by a vascular membrane.

Fig. 107.*



The *thorax*, which is composed of the foregoing bones and cartilages, resembles, when the arms are detached, a truncated cone, the base below, the apex above, flattened before and behind; in some, and often from the effect of dress, it is of an ovoid form, being contracted at the lower part and wide in the middle. The anterior wall is flattened, leads obliquely downwards and forwards, and is shorter than the posterior, which is more vertical, and rendered very irregular by the vertebral grooves, and the angles of the ribs. The sides are convex, particularly behind. The intercostal spaces are short, but wide above, long and narrow in the middle, and again short below; they are broader before than behind. The apex is small, transversely oval, and very oblique from behind forwards and downwards. It is bounded by the first ribs, sternum, and vertebral column, and is also contracted by the clavicles: the trachea, œsophagus, and the cervical vessels and nerves pass through it. The base in the skeleton is undefined; it is very large, also transversely oval, and very oblique from before backwards and downwards. It is bounded by the xiphoid cartilage, the conjoined cartilages of the false ribs, and the vertebral column; it presents a great notch anteriorly, divided into two by the xiphoid cartilage, and posteriorly a small notch

* Anterior view of the thorax. 1. The manubrium or upper piece of the sternum. 2. The second or middle piece. 3. The xiphoid or ensiform cartilage 4. The body of the first dorsal vertebra. 5. The body of the twelfth or last dorsal vertebra. 6. The first rib. 7. The seventh or last true rib. 8. and 9. The last two false ribs, sometimes called floating ribs. 10. The costal cartilages of the true or sternal ribs. 11. The costal cartilages of the superior three false ribs blended together.

on each side of the vertebral column. The axis of this opening is directed downwards and forwards; it is closed by the diaphragm. The axis of the chest is oblique from above downwards and forwards, in consequence of the oblique direction of the sternum; hence, if a line be made to ascend perpendicularly from the base, it will pierce the upper part of the sternum, and not pass through the apex of the cavity. The axis of the cavity, therefore, is not vertical, but leads from above downwards and a little forwards, on account of the obliquity of the anterior wall. The dimensions, and even the form of the chest, vary in different individuals and at different ages, and under a variety of circumstances, normal and abnormal. No accurate estimate of these can be formed from its examination in the skeleton, as the diaphragm which forms its inferior boundary has an extended range of motion, and enlarges or diminishes the cavity in proportion as it descends or ascends (*see* Diaphragm, page 246). Its capacity may be considered as a medium between that of the cranium and abdomen, and bears a tolerably exact ratio to the size of the lungs. Its parietes combine the elements of solidity and mobility, and are thereby fitted not only to protect the heart and lungs, but also to admit of the respiratory motions. The lateral parietes of the thorax also contribute inferiorly to the protection of the abdominal viscera, the extent varying according to the degree of elevation or descent of the diaphragm. The thorax is larger, deeper, and longer in the male than in the female; in the latter it is shorter, but often broader inferiorly than in the former. The thorax presents three diameters, the antero-posterior, the transverse, and the vertical: and these of course must differ in different parts of the cavity. The *antero posterior* is longer below than above, and is shorter in the middle line, in the situation of the heart and great vessels, than at either side, where the chest is expanded on a plane posterior to the bodies of the vertebræ. The *transverse diameter* is greatest between the eighth ribs of opposite sides. The *vertical* is the longest of the three, and is of greater extent on either side than centrally, as the lateral fleshy portions of the diaphragm, which are beneath the lungs, descend much lower than the central tendon which supports the heart. This diameter is subject to greater alterations than either of the others, but they are all increased during inspiration, and diminished by expiration. All these arrangements correspond in an obvious manner with the function of the inclosed organs. In the fœtus, before respiration has commenced, the form of the thorax presents a striking contrast with that of the adult. The cavity is short, and very broad below, flat behind, and compressed upon the sides. The antero-posterior diameter is considerable in the median line, to accommodate the heart and thymus gland, but not so much so on either side, as the posterior concavities formed by the angles of the ribs are not developed. The upper orifice is longer from before backwards than transversely. The vertical diameter is shorter, as the ribs descend less obliquely, and pass round rather in horizontal curves. The intercostal spaces are less, and the bones are more close together. The base or lower circumference is of greater transverse breadth, the ribs of opposite sides being here separated and a little everted to accommodate the great size of the liver. Immediately after birth, when respiration has commenced, the thorax becomes considerably expanded, and the peculiarities just alluded to gradually disappear, until about the period of puberty, when again a considerable increase in size occurs, and the thorax acquires the adult form and character. The motions of the ribs and their cartilages we shall consider when speaking of their ligaments.

SECTION VII.

THE PELVIS

Is the irregularly circular-shaped cavity at the lower end of the trunk. bounded by the sacrum and coccyx posteriorly, and by the ossa innominata laterally and anteriorly; it contains some of the abdominal viscera and many of the urinary and generative organs; it also supports the spinal column above, and transmits the weight to the thigh-bones, on which it rests below. The sacrum and coccyx have been described at page 566. As each os innominatum is divisible in early life into three bones, the ilium, ischium, and pubis, it appears advisable to describe each of these separately in the first instance, and afterwards to consider them as united into a single bone, in which condition they are found after puberty.

Fig. 108.*

The *os ilium* is situated at the upper and outer part of the pelvis, and forms that projection commonly called the hip. It is broad, flat, and triangular, the base above, bounded by a semicircular crest, which ends before and behind in processes or tubercles named spinous; the apex below, forming the upper and outer part of the acetabulum: it may be divided into the body, ala, and processes. The *body* is the inferior constricted portion, which presents three surfaces: one, external, smooth, and concave, forms the upper and outer portion of the acetabulum; the second is anterior, small, triangular, and united to the pubis; the third is posterior, and joined to the ischium. The *ala* is the broad, fanlike semicircular portion, which ascends from the body, inclines outwards and a little forwards. Its *external surface* or *dorsum* is rough and irregularly convex and concave; bounded above by the crest, and below by a prominent arch, which separates it from the body, or from the acetabulum; anteriorly this surface is concave, then very convex; more posteriorly, and above the acetabulum, it is hollowed out into a considerable concavity (external iliac fossa of some), and, lastly, its posterior portion is again convex; it is marked by two curved semicircular lines, a superior and inferior. The *superior* is very long, and usually well marked; commences at the crest, about two inches behind the anterior superior spine, and bends downwards and backwards to the posterior

* A lateral view of the pelvis, showing the os innominatum of the right side. 1. The external surface of the os ilium. 2. The superior curved line. 3. The inferior curved line. 4. The crest of the ilium. 5. The anterior superior spinous process. 6. The anterior inferior spinous process. 7. The posterior superior spine. 8. The posterior inferior spine. 9. The ischium. 10. The groove for the tendon of the obturator externus muscle. 11. The spine of the ischium. 12. The tuberosity of the ischium. 13. The ramus of the ischium. 14. The os pubis; the number is placed at the angle. 15. The horizontal ramus of the os pubis. 16. The descending ramus of the os pubis. 17. The acetabulum. 18. The great notch in the acetabulum. 19. The thyroid or obturator foramen. 20. A lateral view of the sacrum. 21. The great sacro-sciatic notch. 22. The lesser sacro-sciatic notch.

part of the great sciatic notch; to this line, and to a great portion of the bone above it, the glutæus medius muscle is attached. The superior posterior part of the ilium is also marked and subdivided by a short, *oblique ridge*, leading from the back part of the crest, about two inches in front of the posterior superior spine, backwards and downwards, to the posterior inferior spine. To this ridge (by some named superior), and to the rough surface above it, the glutæus maximus is attached. The *inferior semicircular line* commences at the notch above the anterior inferior spine, curves backwards and downwards to the forepart of the great sciatic notch. From this ridge, and from the surface between it and the superior, the glutæus minimus arises. Below this line the bone swells into its prominent body, to form the upper and outer part of the acetabulum. To this prominent surface the glutæus minimus is partly attached, and from it the external tendon of the rectus and part of the capsular ligament arise.

The *internal surface* of the ala is divided into three parts. One, superior and anterior, is the *iliac fossa*, which looks upwards, forwards and inwards; it gives origin to the iliacus internus muscles, and presents the opening of an oblique canal for the nutritious artery of the concellated structure and medulla; it forms the sides of the upper or false pelvis, and supports the abdominal viscera. The second forms about the posterior third of the bone; is rough and divided into two parts, the posterior of which is very uneven, for the attachment of the sacro-iliac ligaments. The anterior is somewhat semicircular, convex forwards, of the form of the external ear, and is covered by a lamina of cartilage, which articulates with the corresponding surface of the sacrum by synchondrosis. The third is smooth and small, and is the only portion of the ilium that enters into the side of the true pelvis: this pelvic portion of the ilium is above the sacro-sciatic notch, and is separated from the iliac fossa by a rounded edge, which is continuous behind with the promontory of the sacrum, and before with a sharper ridge on the pubis. This line is named *ilio-pectinea;* into the posterior portion of it the iliac fascia is inserted, and into the anterior the same fascia, together with the psoas parvus and the third insertion of Poupart's ligament or Gimbernaut's ligament. The iliac portion of this line is remarkably strong, and much thicker than the bone above; these strong, rib-like lines extend from the ilio-sacral symphisis on each side in a direction towards each cotyloid cavity; they form a powerful support to the sacrum, and receive from it the superincumbent weight of the trunk, and transmit the pressure to the acetabula and to the heads of the thigh bones.

The *processes* are, first, the *crest*, which in the young subject is an epiphysis; it forms the upper border of the ala; is curved inwards before and outwards behind; is convex above, and alternately convex and concave from before backwards, like an italic *S;* it gives attachment to the three layers of abdominal muscles, also to the latissimus dorsi and fascia lata of the thigh externally, and to the iliac fascia internally. Second, *anterior superior spine* is the prominent projection at the upper and forepart of the crest and ala; it gives attachment to Poupart's ligament and to two muscles, the sartorius and tensor vaginæ femoris. Between this and the next process is a notch. Third, *anterior inferior spine* is above the outer part of the acetabulum; it gives attachment to one head of the rectus femoris muscle. The notch between these processes is occupied by the sartorius and iliac muscles and an external cutaneous nerve. Internal to the inferior spine is a superficial groove, along which the psoas and iliac muscles pass. This groove is bounded internally by the *ileo-pectinæal eminence*, which is common to and formed by the union of the ilium and pubis. Fourth, the *posterior superior spine* is the posterior termination of the crest, below which is a notch: and, fifth, the *posterior inferior spine.* These two processes give attachment to muscles and to the

sacro-iliac and sciatic ligaments. Beneath the inferior the bone is arched to form the upper boundary of the sacro-sciatic notch.

The *ischium* is placed at the lower, outer, and back part of the pelvis, and presents a body and processes. The *body* forms the outer, lower, and back part of the acetabulum, more than two-fifths of which it forms, and presents a prominent line or border. Beneath this is a horizontal groove, which lodges the tendon of the obturator externus, in its course to the trochanteric fossa; and from this a rough ridge leads down to the tuber of the bone, and gives attachment to the quadratus femoris muscle. The anterior part of the body is thin and sharp, and bounds the obturator or thyroid hole inferiorly and externally; the posterior part joins the ilium, and bounds the sacro-sciatic notch anteriorly. The processes are, first, the *spine*, which arises from near the middle of the posterior part, just below the sacro-sciatic notch: it projects backwards and inwards, gives attachment to the superior gemellus and to the lesser sciatic ligament, with which it bounds the great sciatic notch inferiorly, and converts it into a large foramen. Below the spinous process, between it and the following, is the smooth pulley round which the tendon of the obturator internus muscle turns. Second, the *tuberosity* which is beneath this pulley. On this rough and broad process the body rests in the sitting posture; it is covered with cartilage, and marked by three flattened facets; to the anterior the semimembranosus muscle is attached, to the two posterior the biceps and the semitendinosus; to the outer the adductor magnus, inferior gemellus, and quadratus femoris; its inner edge is sharp, and projects a little into the cavity of the pelvis. To this and to a corresponding edge on the ramus a portion of the great sciatic ligament is attached, so as to form a grooved surface to support the pudic vessels and nerves. Between the spine and tuberosity is the lesser sciatic notch, which is converted into a foramen by the great sciatic ligament, which bounds it posteriorly; the pulley bounds it in front. Third, the *ramus* ascends from the tuber forwards and inwards, and joins that of the pubis; it is flat, narrow, and a little everted; one border is thin, and bounds the thyroid hole inferiorly and internally, the other is thick, and in part bounds the lower aperture of the pelvis. To it are attached the crus of the penis or of the clitoris, and its compressor muscle.

The *os pubis* is situated at the forepart of the pelvis, and is smaller than the ilium or ischium. It may be divided into its body and processes. The *body* is the most external portion, is thick, and forms the internal and superior part of the acetabulum, above which it joins the ilium in the ileo-pectinæal eminence, and below it is united to the body of the ischium; its posterior surface is smooth and flat, and forms the anterior wall of the pelvis. From the body the first process proceeds, the *horizontal ramus*, forwards and inwards, smooth and concave superiorly, and covered by the pectinæus; smooth also posteriorly towards the cavity of the pelvis, and grooved beneath, where it bounds the obturator foramen, and gives passage to the obturator vessels and nerve. A sharp ridge separates its superior from its posterior surface: this ridge is the anterior part of the linea innominata or ileo-pectinæa, which forms the brim of the true pelvis. Into the pubic portion of this line the pectinæus muscle, Gimbernaut's ligament, and the fascia lata, are inserted. Anterior and external to this ridge, the ramus is slightly concave, and supports the femoral vessels; external to which is the ileo-pectinæal eminence, and still more externally and on the ilium is the groove for the psoas and iliac muscles. At the internal extremity of this ramus and of this line is the second process, the *tuberosity* or *spine*. This is a prominent tubercle into which Poupart's ligament is inserted. From this spine the third process, the *crest*, leads transversely inwards; it is about an inch in length: the rectus abdominus and pyramidalis muscles, also the conjoined tendons of the transversalis and internal oblique, are attached to it. At its internal end

is the fourth process, the *symphisis*. This descends nearly vertical, is rough and oval, and is joined to the opposite one by an intervening fibro-cartilage. As the symphisis turns down from the transverse crest there is the *angle* of the pubis. From the lower part of the symphisis descends the fifth process, the *inferior* or *descending ramus*, in an oblique direction, backwards and outwards, to meet the ramus of the ischium; this with the ramus of the opposite pubis forms the *arch of the pubis;* the outer edge of the ramus assists in bounding the thyroid hole.

When these three bones are conjoined, as they are in the adult, they constitute the *os innominatum*, or *haunch bone*, the form of which must be very irregular. It is articulated posteriorly to the sacrum, and anteriorly to its fellow in the symphisis pubis; it forms the side and front of the pelvis, and presents externally, a little below its centre, the acetabulum for the head of the femur. From this cavity the three portions diverge, the ilium passing upwards and backwards, the pubis inwards, forwards, and then downwards, and the ischium first downwards, then upwards and inwards, to join the pubis. The middle portion, or that corresponding to the acetabulum, is narrow and somewhat twisted, so that the inner surface of the upper or iliac portion looks upwards, forwards, and inwards, while the same surface of the lower or pubic and ischiatic portions looks backwards, upwards, and inwards. The *superior border* of the os innominatum is bounded by the crest of the ilium, curved and terminating before and behind in the spinous processes, already described. The *anterior border* extends from the anterior superior spinous process of the ilium to the symphisis pubis; is formed by the ilium externally and pubis internally, and is irregularly convex and concave; below the anterior superior spine is the notch which contains the sartorius muscle; then the inferior spinous process, internal to which is the wide groove for the psoas and iliac muscle: next is the ileo-pectinæal eminence, internal to which is the smooth and slightly concave surface of the pubis, which supports the femoral vessels and the pectinæus muscle; of a triangular form, the apex internally at the spine or tubercle, and bounded posteriorly by the ileo-pectinæal ridge. Internal to the spine is the crest leading inwards to the angle at the symphisis. The *posterior border* of the os innominatum extends from the superior posterior spine of the ilium to the tuberosity of the ischium; it is very irregular, and presents first a notch; then the posterior inferior spine; below this the great sciatic notch, bounded below by the spine of the ischium; beneath which is the lesser sciatic notch, or pulley, for the obturator internus tendon, and lastly, the tuber ischii. The *inferior border* extends from the tuber ischii obliquely upwards, forwards, and inwards, to the angle at the upper edge of the symphisis pubis. The *internal* or *pelvic surface* presents, superiorly and posteriorly, the rough surface for the attachment of the sacro-iliac ligaments; anterior to which is the auricular-shaped surface for articulation with the sacrum. The remainder of this inner surface is divided into a superior and inferior portion by the ileo-pectinæal line, which is round posteriorly, and formed by the ilium, and sharp in its anterior or pubal portion. Above this line is the iliac fossa; below it the bone is smooth and concave posteriorly, and anteriorly it presents the obturator foramen, between the pubis and ischium. The *external surface*, in its superior portion, looks backwards, outwards, and downwards; is irregularly convex and concave; and is marked by the glutæal semicircular lines. The anterior inferior portion looks downwards, outwards, and forwards, and presents the acetabulum with its prominent margin, and more internally the obturator foramen, and inferiorly the tuber ischii, between which and the acetabulum is the groove for the external obturator tendon; and, lastly, to the inner side of the obturator hole, the rami of the ischium and pubis, leading upwards and inwards to the oval symphisis, and

presenting a flat surface, narrow in the centre, and marked with a rough line at this point of union.

The *acetabulum* is formed by the junction of the bodies of the three bones in different proportions; the ischium constitutes a little more than two-fifths, the ilium somewhat less than two-fifths, and the pubis the remainder, or one-fifth. It is surrounded by a prominent border, which presents a deep notch or deficiency internally, and two smaller notches or grooves, one superiorly, the other inferiorly and externally. The *great notch* is opposite the thyroid hole, between the ischium and pubis, but chiefly in the former bone; it is at the anterior and inferior part, and is converted into a foramen by a ligament extended over it from the pubis to the ischium: it may serve to admit of more free adduction of the limb; it also allows the articular vessels to enter the joint. A rough surface, perforated by nutrient foramina, and the only part uncovered by cartilage, leads from it to the centre of the cavity; to this and to the edges of the notch the articular ligament and a quantity of adipose tissue are connected. The cotyloid cavity looks outwards, downwards, and forwards; the upper and outer portion, by which the weight of the head and trunk are transmitted to the thigh, is the deepest; it is shallow at the lower and internal part. The pubis bounds it anteriorly and internally, the ilium superiorly, and the ischium posteriorly; it is of a hemispherical form, and about two inches and a half in diameter; its prominent margin, uneven and notched, gives attachment to the glenoid fibro-cartilaginous brim which contracts the orifice and deepens the cavity.

The *obturator* or *thyroid foramen* is situated at the inner side of the acetabulum, and on an inferior level. In the male it is oval; in the female it is smaller and triangular, the narrow part below; its long diameter is oblique from above downwards and outwards; the edge is thin and uneven, and interrupted superiorly by a groove which leads from within the pelvis obliquely forwards, downwards, and a little inwards. Through this canal the obturator nerve and vessels pass. The remainder of the opening is closed by a strong fibrous membrane, to the surfaces of which, and of the adjacent bone, the obturator internus and externus muscles are attached. It is bounded above by the pubis, externally and inferiorly by the body and ramus of the ischium, and internally by the united rami of the pubis and ischium. Superiorly it presents two lips; the anterior is continuous with the external half of its margin, the posterior with its inner half; the inner passes backwards and the outer forwards, and the obturator groove is between them. Around the pelvic or internal margin this bone is depressed into a fossa for the internal obturator muscle.

The *pelvis*, which is thus made up of the ossa innominata, the sacrum, and ossa coccygis, may next be examined as one great portion of the skeleton, placed in an inclined position between the spine and the lower extremities, and bounding a large cavity, wide and open above into the abdomen, and contracted below towards the perinæum. Internally this cavity is imperfectly divided by the brim or the linea ileo-pectinæa into two regions, the superior or false, the inferior or true pelvis. Externally the pelvis presents in front the symphisis and crests of the pubes, the ileo-pectinæal eminences; beneath these the acetabula and the thyroid holes, and more externally the anterior spinous processes of the ilium; laterally the dorsum of the ilium, marked by its curved lines; and posteriorly the sacral spines in the median line, external to which are the sacral foramina; beyond these, on each side, a rough surface for the attachment of ligaments and muscles; and, lastly, the great sacro-sciatic notches, bounded by the sacrum, ilium, and ischium. The *superior* circumference or *base* of the pelvis, which is inclined upwards and forwards, is formed on each side by the crest of the ilium; posteriorly by the promontory of the sacrum, on each side of which is a deep notch, filled by muscles;

anteriorly by the iliac spines, ilio-pubal eminences, the intervening grooves, and crests and symphisis of the pubes. The *lower* or *perinæal* circumference, or strait or apex or outlet of the pelvis, is directed downwards and a little forwards; bounded by the rami of the pubes, the rami and tubera ischii, the coccyx, and in the recent state by the sacro-sciatic ligaments of each side; but when the latter have been removed, as in the artificial skeleton, then this strait presents three great notches: first, the arch of the pubis, triangular, and placed beneath the symphisis; the second and third are placed between

Fig. 109.*

the sacrum and os innominatum of each side, very large in the dried bones, but in the recent state they are divided by the sciatic ligaments each into two, the *greater* and the *lesser*. The *greater* or *superior sacro-sciatic notch*, or foramen, is bounded above and before by the ilium, behind by the sacrum, and below by the spine of the ischium and by the lesser or anterior sacro-sciatic ligament, which extends from this process to the sacrum. This notch transmits the pyriform muscle, the glutæal, sciatic, and pudic vessels and nerves. The *lesser* or inferior sacro-sciatic notch, or foramen, is a small triangular space, between the spine and tuber ischii, and completed above by the anterior, and below by the posterior or great sacro-sciatic ligament; it transmits the tendon of the internal obturator muscle in its passage to the trochanteric fossa, also the pudic vessels and nerves in their returning course into the pelvis.

The *internal surface* of the pelvis is divided into two by the prominent line before mentioned, the linea ileo-pectinæa, which leads around from the symphisis and spines of the pubes to the promontory of the sacrum; below this line is the *true*, above, the *false* pelvis.

The *false pelvis* is properly part of the abdomen, and is too imperfect in the skeleton to merit the name of a cavity. It is bounded anteriorly by the

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* An anterior view of the pelvis. 1. The base of the sacrum. 2. The promontory of the sacrum. 3. The oblique or articular process. 4. The anterior surface of the sacrum. 5. The anterior sacral foramina. 6. The iliac fossa. 7. The crest of the ilium. 8. The anterior superior spinous process 9. The anterior inferior spinous process. 10. The ileo-pectinæal eminence. 11. The acetabulum or cotyloid cavity. 12. The inferior notch in the acetabulum. 13. 13. The great sacro-sciatic notch. 14. The groove for the tendon of the obturator externus. 15. The spine of the ischium. 16 The tuberosity of the ischium. 17. The ramus of the ischium. 18. The thyroid or obturator foramen. 19. The horizontal ramus of the os pubis. 20. The tuberosity or spine of the os pubis. 21. The crest. 22. The symphisis. 23. The descending ramus of the os pubis. 24. The arch of the pubis.

abdominal muscles and tendons, posteriorly by the lumbar vertebræ and lumbar muscles, and laterally by the iliac alæ, which look upwards, inwards, and a little forwards, support the intestines, and direct the weight partly forwards against the abdominal parietes. The longest diameter of this region is the transverse, and its axis is nearly vertical, or a little oblique from above downwards and backwards.

The abdominal or *upper strait* or *inlet* of the true pelvis is bounded posteriorly by the promontory of the sacrum, anteriorly by the symphisis and crests of the pubes, and on either side, where it expands, by the ileo-pectinæal line. Its form is somewhat oval, or rather heart-shaped, as the pubic boundary in front is narrower than the sacral promontory behind, which encroaches upon the opening. It presents anteriorly in the median line the pubic, and on either side posteriorly the ilio-sacral symphisis. It offers for measurement four diameters: first, the antero-posterior or sacro-pubic, which is the shortest on account of the projection of the sacrum; second, the transverse or iliac, which crosses the first at right angles, and is the longest; third and fourth, the oblique, leading from one ilio-sacral articulation to the opposite ilio-pubal eminence, or cotyloid wall.

The *true* pelvis, which is beneath this strait, is a sort of curved canal. longer than the false pelvis, and wider about the centre than at either end; with smooth walls, concave posteriorly from above downwards, concave anteriorly in the transverse direction, and on either side nearly plane. The sacrum and ossa coccygis form its posterior boundary, nearly five inches in length; the anterior or pubic wall is much less, from an inch and a half to two inches; on either side it becomes wide and deep, about four inches and a half, and presents anteriorly the thyroid or obturator foramina, closed by fibrous membrane, external to which there is a slight convexity corresponding to the bottom of the acetabulum, and more posteriorly the sacro-sciatic notches, which extend upwards to within an inch of the linea innominata, and downwards, in the skeleton, to the outlet or lower orifice of the pelvis, but in the recent state are separated therefrom by the great sacro-sciatic ligaments, which extend from the sacrum and coccyx to the tubera ischii, and form part of the lateral boundaries of the outlet. Each side slants a little downwards and inwards; the cavity is, therefore, smaller below than above. The true pelvis is placed in an oblique direction, its upper orifice looking forwards, and the inner surface of the pubes upwards, so as to support the abdominal viscera: a line, passed horizontally from the upper border of the symphisis pubis backwards, will meet the middle, or rather the lower end of the sacrum. The lower orifice or outlet looks forwards and downwards; is smaller, but admits of change of form and size more than the upper. If the planes of the two openings of the true pelvis be produced anteriorly, they will unite about two inches in front of the symphisis, at an acute angle, the base of which will be the sacrum and coccyx. The outlet or perinæal strait is bounded anteriorly by the symphisis and rami of the pubes and ischia, laterally by the tuberosities of the ischia and by the sciatic notches, and posteriorly by the sacrum and coccyx, to the borders of which those notches extend. This plane presents three eminences and three notches: the eminences are the coccyx posteriorly and the tuber ischii on either side; the notches are the pubic arch before and the sciatic notches laterally and posteriorly. This opening, however, when viewed with the ligaments attached, presents a very different appearance; it is then much more contracted, and has a lozenge or diamond form; the coccyx and symphisis being the posterior and anterior angles, and the tubera the lateral, the margins formed posteriorly by the great sciatic ligaments, and anteriorly by the rami of the ischium and pubis. This strait also presents four diameters, the antero-posterior, the transverse, or that between one tuber ischii and the other, and the two oblique, leading from the centre of each great sciatic

ligament to the opposite tuber ischii. The oblique and transverse are nearly equal, about four inches ; the antero-posterior is nearly the same, but variable on account of the mobility of the coccyx. The axes of the two orifices of the true pelvis are not the same ; that of the superior, if produced, would pass anteriorly through the abdominal muscles, between the pubis and umbilicus, and posteriorly it would rest against the lower end of the sacrum. The axis of the lower strait, if produced from below upwards, would impinge against the promontory of the sacrum ; these lines, therefore, will decussate near the centre of the pelvis, and form an obtuse angle forwards. The axis of the cavity itself cannot be parallel to that of either of the openings. The *pelvic axis* is represented by a curved line passing through the centre of the upper plane, and descending through the cavity, parallel to the curve of the sacrum, and escaping through the centre of the lower plane. The axis of the inlet corresponds to a line passing through its centre, and directed from beneath the umbilicus downwards and backwards to the lower part of the sacrum ; the axis of the outlet to a line directed from the promontory of the sacrum, downwards and forwards, through the centre of its plane.

The *female pelvis* differs from that of the male in several circumstances; it is wider and larger, but not so deep ; the alæ of the ilium are more expanded, the prominence of the sacrum is less, the inlet and outlet are rounder and wider, the sacrum is broad and more concave, the pubic arch more round and open, the symphisis pubis is not so deep, the obturator holes are smaller and triangular, the sciatic tuberosities are directed more outwards, and the acetabula are more distant from each other, and all the bones are more thin and delicate. The *male* pelvis is deeper, narrower, and the bones are more solid and strong. The dimensions of the male and female pelvis are given by Meckel as follows, tom. i. p. 473 :

	In the Male.		In the Female.	
	Inch.	*Lines.*	*Inch.*	*Lines.*
The transverse diameter of the great pelvis between the anterior superior spinous processes of the ilia, ...	7	8	8	6
Distance between the cristæ of the ilia, ...	8	3	9	4
Transverse diameter of the superior strait, ...	4	6	5	0
Oblique diameter of the superior strait, ...	4	5	4	5
Antero-posterior diameter of the superior strait, ...	4	0	4	4
Transverse diameter of the cavity, ...	4	0	4	8
Oblique diameter of the cavity, ...	5	0	5	4
Antero-posterior diameter of the cavity, ...	5	0	4	8
Transverse diameter of the lower strait or outlet, ...	3	0	4	5
Antero-posterior diameter of the lower strait or outlet, . . .	3	3	4	4
The latter may be increased to five inches from the mobility of the coccyx.				

In the fœtus the pelvis is very small and deep, and narrow transversely ; the true and false are nearly in the same perpendicular line ; the acetabula are nearer the middle line, and look more outwards ; they are not beneath the pelvis, as in the adult ; hence the thigh-bones in the infant cannot support or balance the weight of the trunk. The iliac alæ are flat, and the plane of the inlet is very oblique.

The ossa innominata are composed of two thin but compact laminæ, with an intervening diploe ; the latter is nearly wanting in the iliac fossæ, where the bones are transparent, as well as in the rough surfaces in the cotyloid cavities.

In the fœtus each os innominatum is *developed* from three points of ossification, one for the ilium, one for the ischium, and one for the pubis : these points are all in or near to, and soon unite in the acetabulum. About twelve

years of age additional points are added, one for the crest, one for the tuber ischii, and sometimes one for the anterior inferior spine of the ilium, and sometimes one for the angle of the pubis; also one of a Y form, in the acetabulum, between the three primitive pieces. These several ossific points are not completely united before twenty-three or twenty-four years of age. In some females, also, a plate of bone or epiphysis rises as a spine from the crest of the pubis, and occasionally grows so large and remains so movable as to resemble the ruidiments of a marsupial bone.

SECTION VIII.

THE BONES OF THE EXTREMITIES.

The *extremities*, or limbs, are four in number, two superior or thoracic, and two inferior or abdominal. The superior serve as instruments for prehension, tact, defence, and offence, and are connected to the thorax each by one articulation only. The inferior are longer and stronger, and serve as pillars for support, and as passive agents in locomotion; they are connected to the pelvis each by one articulation also. The upper and lower extremities, though intended for different purposes, yet present several analogies as to form and arrangment. We shall first consider the inferior.

The *inferior extremity* is divided into three parts, the thigh, leg, and foot; the latter is subdivided into the tarsus, metatarsus, and toes. The thigh has one bone, the femur; the leg three, the patella, tibia, and fibula; the tarsus seven, the astragalus, calcaneum, cuboid, scaphoid, and three cuneiform; the metatarsus five, and the toes fourteen: thirty bones in all. Some consider the os innominatum a part of the inferior extremity, as the shoulder is of the upper; the ilium and ischium being analogous to the scapula, and the pubic to the clavicle.

The *femur* is the longest and strongest bone in the system, and is longer in man, in proportion, than in any other animal; from the pelvis it is directed obliquely downwards and inwards: this obliquity is greater in the female than in the male; it consists of the body or shaft and two extremities.

The *body* is slightly twisted, thick above, very broad below, contracted and nearly cylindrical in the centre, arched, convex, and smooth before, and concave behind, with a rough, projecting ridge down the centre, named the *linea aspera*, very strong and peculiarly hard along the middle third of the bone; is parallel to its axis, and strengthens the concave surface of the bone so as to resist its flexion under longitudinal compression; it is more rugged above than below, and divides at either end into two ridges; these pass superiorly one to each trochanter, that to the inner being shorter, that to the outer broader, longer, more vertical, rough, and prominent: the inner line, however, may be traced forwards, around the lesser trochanter, to the anterior intertrochanteric line. Between these two branches is a flat, triangular surface, in the middle of which is a ridge to which some fibres of the quadratus femoris are attached; the inferior divisions lead, one to either condyle; that to the inner is much less prominent than that to the outer. These inferior divisions are longer than the superior, separate further, and inclose a flat, triangular space, the popliteal. The linea aspera is very prominent about the centre, and presents two lips and an interstice for the attachment of different muscles. The anterior surface of the femur is broader and flatter towards either end than in the centre; it is a little concave superiorly; the sides are slightly flattened, and the external is somewhat narrower than the internal,

Fig. 110.*

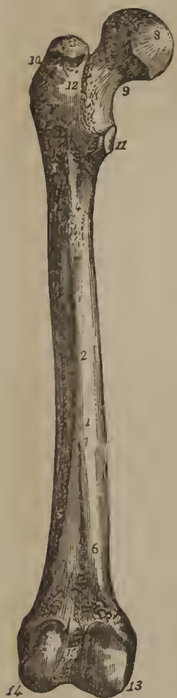
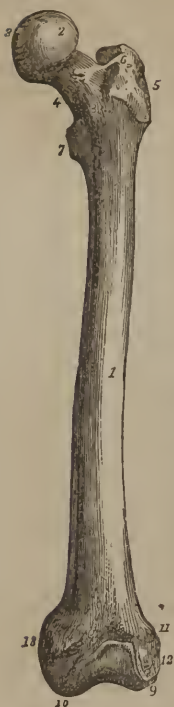


Fig. 111.†



particularly above. Above the middle of the linea aspera one or two holes may be seen to enter obliquely upwards ; these transmit the nutritious or the medullary vessels of the bone ; to the linea aspera, in the middle of the thigh, the vastus externus, the adductor tendons, and the vastus internus, are attached ; to its superior external branch, which leads to the great trochanter, and is very long and rough, the adductor magnus, glutæus maximus, and vastus externus are attached. The internal branch, short and not very distinct, leading to the lesser trochanter, gives attachment to the adductor brevis, pectinæus, vastus internus, and some of the fibres of the iliacus internus. To the lower and external branch of the linea aspera the vastus externus and short head of the biceps are attached, and to the lower and internal the vastus internus and adductor magnus adhere. These lines continue as low as the condyles ; the internal is smooth, and nearly obliterated near its middle for the passage of the crural artery.

The *upper* or *pelvic extremity* of the femur presents three eminences, the head for articulation with the cotyloid cavity, and the trochanters for the insertion of muscles. The *head* is of a globular figure, and forms a considerable segment of a sphere ; it is directed upwards, inwards, and a little forwards : a little below its centre there is a rough, oval depression for the insertion of the round or articular ligament. With the exception of this depression the head is covered throughout with cartilage : it is supported by a strong, elongated process, of a pyramidal form—the *neck*, which forms an angle, more or less obtuse, with the shaft of the bone. The direction of this process is upwards, inwards, and a little forwards ; it is flattened before, smooth, concave, and longer behind ; it is stronger, and can, therefore, better resist force or pressure in the direction of its vertical diameter than in its antero-posterior ; is thicker at the shaft than at the head ; its lower edge is longer and firmer than the upper, which is thick and short. A rough, irreg-

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* A posterior view of the left femur. 1. The body or shaft. 2. The linea aspera. 3. The superior external branch of the linea aspera extending upwards to the great trochanter. 4. The superior internal branch passing towards the lesser trochanter. 5. The inferior external division of the linea aspera descending to the external condyle. 6. The inferior internal division. extending to the internal condyle. 7. One of the nutritious foramina. 8. The head. 9. The neck. 10. The great trochanter. 11. The lesser trochanter. 12. The posterior intertrochanteric line. 13. The internal condyle. 14. The external condyle. 15. The deep notch which separates the condyles posteriorly.

† An anterior view of the left femur. 1. The shaft or body. 2. The head. 3. The depression for the insertion of the ligamentum teres. 4. The neck. 5. The great trochanter. 6. The digital fossa of the great trochanter. 7. The lesser trochanter. 8. The anterior intertrochanteric line or ridge. 9. The external condyle. 10 The internal condyle. 11. The tuberosity for the attachment of the external lateral ligaments of the knee-joint. 12. The groove which receives the tendon of the poplitæus muscle. 13. The tuberosity for the attachment of the internal lateral ligament.

ular line separates the head from the neck, beyond which the articular cartilage of the former does not extend; its upper and its anterior surfaces are each perforated by numerous foramina for vessels. At its juncture to the shaft two rough lines extend inwards, and downwards from the great to the lesser trochanter, one on the fore, the other on the back part of the bone; into these the capsular ligament is inserted. The neck is short in the child, long and oblique in the adult male; it is shorter and more horizontal in the female, forming nearly a right angle with the shaft: in old age, also, it often becomes shortened and depressed by interstitial absorption, so that the head sometimes sinks below the level of the great trochanter, and becomes nearly contiguous to the shaft.

The *great trochanter* is continuous with the external side of the shaft, and nearly in a line with its axis, and on a little lower level than the head; it is thick, rough, and square; externally it is broad and convex, and prominent beneath the skin; the tendon of the glutæus maximus moves over this surface and an intervening bursa; a prominent ridge bounds it below, to which some fibres of the vastus externus are attached. Internally it presents a pit, or digital cavity, which receives the tendons of the external rotators of the limb, namely, the pyriform, gemelli, and obturators. The summit of the trochanter is thick and rough; is curved a little inwards, so as to overhang the digital fossa. Into it, and into an oblique ridge on its outer surface, the glutæus medius is inserted; the anterior edge is broad, and presents superiorly a depression for the attachment of the glutæus minimus. Into the posterior, which is round and thick, the quadratus femoris is inserted.

The *lesser trochanter* is a conicle tubercle at the posterior and inner side of the shaft, considerably below the level of the great trochanter, and below the base of the neck; it looks backwards and inwards; the tendons of the psoas and iliac muscles are inserted into it behind its apex; a small bursa is sometimes connected to it anteriorly, and another posteriorly.

The inferior or *tibial end* of the femur is very large and broad, flattened before and behind, and divided into two eminences or *condyles*, which are separated posteriorly by a deep notch, and continuous anteriorly with each other and with the shaft, through the trochlea, for the patella. The *condyles* articulate with the tibia. The *external* is larger, and projects more forward than the internal; its articulating surface is also broader, and ascends higher. Externally it is rough, and presents a tuberosity which gives attachment to the external lateral ligament of the knee-joint; this is less prominent than the internal tubercle. Beneath it is a groove which receives the tendon of the poplitæus muscle in the flexed position of the joint. Internally this condyle presents a rough surface, towards the posterior part of which the anterior crucial ligament is inserted; it is very convex behind, flat before, and broad below. Above and behind it arise the outer head of the gastrocnemius and plantaris muscles. The *internal condyle* is narrower, less prominent before, but prolonged more behind; it is also longer than the external, and therefore descends lower when the femur is vertical, but both are nearly on a level when the bone is in its ordinary oblique direction. On its inner side is the tubercle for the attachment of the internal lateral ligament of the knee and for the adductor tendon. To its outer side, which is rough, the posterior crucial ligament adheres. Both condyles are more convex behind than before; they are separated posteriorly by a deep, uneven notch, which lodges the crucial ligaments, and is deprived of articular cartilage. Anteriorly they are continued into each other, and unite in a *trochlea* on which the patella moves, and which is convex from above downwards, and concave from side to side, higher externally than internally, and chiefly formed on the external condyle. The femur is articulated superiorly with the ilium, inferiorly with the tibia, and anteriorly with the patella. Like all long bones, it is composed

of compact tissue in the centre, and cancellated at the extremities; the compact has a fibrous appearance. The whole shaft is traversed by a distinct medullary canal, which is crossed by numerous bony laminæ. The femur is *developed* by five points of ossification, one for the shaft, one for the tibial end, one for the head, and one in each trochanter. Ossification commences in the shaft so early as the beginning of the second month, and the ossific point in the lower end is constantly present (according to Cruveilhier) during the last fifteen days of fœtal life: that in the head of the bone commences during the first year after birth; the neck extends from the shaft, and is not a distinct portion. Ossification commences in the great trochanter about the third year, and in the lesser about the twelfth. The lower extremity of the femur is the only epiphysis in which ossification commences before birth, and it is the longest to continue separate, not being united to the shaft until after the twentieth year.

The bones of the *leg* are the patella, tibia, and fibula.

The *patella* or *rotula*, or knee-cap, is a small bone in front of the knee-joint, triangular or heart-shaped, the base above, the apex below; its anterior surface is convex and covered by skin, a bursa, and some tendinous fibres; it is marked by several longitudinal lines, and presents a very fibrous appearance. The posterior surface is covered with cartilage, and divided by a prominent vertical line, which descends a little inwards, into two lateral portions. Of these the external is larger and deeper than the internal. Beneath these is a small, triangular, depressed surface, into which the ligament of this bone is inserted. The upper edge is round, and cut off obliquely backwards and downwards; to it the extensor tendons are attached. The patella is of a cellular structure, covered by a compact lamina, which is very dense, and traversed by longitudinal striæ; it is developed from a single point of ossification, and remains for a long time cartilaginous; it commences between the second and third year, and is completed about the fourteenth. It is articulated with the condyles of the femur, and connected to the tibia by a powerful ligament; it protects the forepart of the knee, and serves as a medium of connection between the extensor tendon and the leg. When the limb is extended it is movable, and may rise above the trochlea; when flexed, it is fixed and prominent.

Fig. 112.* Fig. 113.†

The *tibia*, next to the femur, is the longest bone in the skeleton; it occupies the anterior and inner part of the leg; its direction is vertical, whereas that of the femur is obliquely downwards and inwards; the tibiæ of opposite sides are parellel. Its upper extremity is thick, and expanded from side to side; the circumference somewhat circular or oval, convex on the front and sides, but slightly grooved behind. On either side is a *protuberance;* that on the internal is the more prominent for the insertion of the internal lateral ligament and for the tendon of the semimembranosus muscle, one portion of which is attached to a groove on its posterior aspect. A little behind the external tuberosity is a small rounded surface, looking downwards and a little backwards and outwards; it is covered with cartilage for articulation with the head of the fibula. On the anterior part of the head is a convex, triangular surface, directed forwards and downwards, pierced with many vascular holes, and terminating in a tubercle, to the upper part of which a bursa

* The anterior surface of the left patella. 1. The anterior convex surface. 2. The base. 3. The apex. 4. Its external border. 5. Its internal border.

† The posterior surface of the same bone. 1. The large concave facette which articulates with the external condyle of the femur. 2. The smaller facette, which joins the internal condyle of the femur. 3 The base. 4. The apex.

adheres, and into the lower the ligamentum patellæ is inserted.

The upper or femoral surface of the tibia presents two concave or articulating surfaces or *condyles,* or rather glenoid cavities, covered with cartilage for articulating with the femur. The *internal* is oval, and the deeper of the two; it is also larger from before backwards. The *external* is nearly circular, very superficial, and inclined obliquely downwards and outwards. These are separated by a *spine,* which is of a pyramidal form, inclines upwards and inwards, and is surmounted by two tubercles; it is nearer the back than the forepart of the bone: a large, flat, depressed surface lies anterior to it, and a smaller depression behind it: the semilunar cartilages and the crucial ligaments are inserted into these.

Fig. 114.* Fig. 115.†

The *body* or shaft of the tibia is triangular; its size diminishes from the head for about two-thirds down, it then increases somewhat towards its lower end; its inner side is convex above, a little concave below, directed obliquely forwards, and covered superiorly by the tendinous expansions of the sartorius, gracilis, semitendinosus and membranosus; the remainder of it is subcutaneous. The external side appears a little twisted; it is concave above to support the tibialis anticus muscle, convex below, to support the tendon of that muscle, as also those of the extensors. The posterior surface, which is also broader above than below, is slightly convex, and presents superiorly a prominent line passing obliquely downwards and inwards for the insertion of the poplitæus, and for the origin of the solæus and the deep flexors. Near this line is the opening of the large canal that leads the vessels to the medullary membrane, slanting obliquely downwards and forwards. The tibia presents three edges; one is anterior, and commences from the tuberosity; it is very prominent about the middle, but less so above, and rounded below; this line is subcutaneous; it is twisted like the tibia itself, and is commonly called the crest or the shin. The inner edge is thick and round, and more distinct below than above: the outer edge is thin, and gives attachment to the interosseous ligament; it is less distinct and bifurcated below.

The lower or *tarsel end* of the tibia is somewhat square, presents an anterior convex edge, covered by the extensor tendons; a posterior nearly smooth edge traversed by a groove for the tendon of the flexor pollicis longus; ex-

* The posterior surface of the left tibia. 1. The head. 2. The spine. 3. The internal tuberosity. 4. The external tuberosity. 5. The surface for articulation with the head of the fibula. 6. A rough ridge to which the poplitæus muscle is attached. 7. The internal border of the shaft. 8. The external border. 9. The oblique orifice of the vascular canal. 10. The lower extremity of the tibia. 11. The internal malleolus. 12. The groove for the tendons of the tibialis posticus and flexor digitorum longus. 13. A rough surface, which receives the lower end of the fibula.

† An anterior view of the left tibia. 1. The head of the tibia. 2. The external tuberosity. 3. The internal tuberosity. 4. The external superior articular surface. 5. The internal superior articular surface. 6. The spine. 7. The tubercle. 8. The external surface of the shaft of the bone. 9. Its internal or subcutaneous surface. 10. The anterior edge or crest of the tibia. 11. The lower extremity of the tibia. 12. The internal malleolus. 13. The surface which articulates with the lower extremity of the fibula.

ternally is a concave triangular surface, rough above for ligaments, more smooth and cartilaginous below to receive the lower end of the fibula; internally a thick, flattened perpendicular process, the *internal malleolus* or ankle convex and subcutaneous, bent a little inwards, and prominent beneath the skin; it lies anterior to the superior internal tuberosity or condyle, on account of the twisting of the bone. The outer side of this process is smooth and cartilaginous, and joined at right angels to the cavity at the lower end of the bone; it is articulated to the side of the astragalus; its anterior edge is convex, and gives attachment to ligaments; its posterior edge is grooved superficially for the tendons of the tibialis posticus and flexor communis: this groove is sometimes double. The extremity of this process is broad, and descends lower before than behind; it gives origin to the internal lateral ligament of the ankle. The lower surface of the tibia is quadrilateral, concave from before backwards, and somewhat convex from side to side, being traversed from before backwards by a very superficial ridge or prominence. This surface is broader externally; it is bounded internally by the internal malleolus, and externally by the fibula. The tibia is articulated to the femur, the fibula, and astragalus. Ossification commences in three points, one for the shaft, and one for each extremity; the tubercle at the upper end of the crest and the malleolus are sometimes found as epiphyses.

Fig. 116*. Fig. 117.†

The *fibula* is very slender, and nearly as long as the tibia; it is placed at the outer side of the leg, nearly vertical, its lower end inclined a little forwards; below it is directly to the outer side of the tibia, but above it is also somewhat posterior to it. The superior or *femoral end* is small and circular, and presents a slight cavity forwards, upwards, and inwards, to articulate with the tuberosity on the external condyle of the tibia. Behind this is a slight pyramidal projection; its whole circumference is rough for the insertion of ligaments which attach it to the tibia, also for the external lateral ligament of the knee-joint and for the tendon of the biceps; below this the bone is round and slender, like a *neck*; the *body* then becomes triangular, is a little curved backwards and inwards above, but is twisted forwards below. This is divided into two portions by the internal edge, into which the interosseous ligament is inserted; the anterior portion gives attachment to the extensors, and the posterior, which is larger, is grooved for the tibialis posticus. Its external surface is covered by the peronæi muscles; the posterior surface gives attachment to the solæus above and to the flexor pollicis below. In this surface we perceive the orifice of the vascular canal leading downwards; the internal edge, which is turned a little forwards, gives attachment to muscles above and to the interosseous ligament below; the external edge is turned backwards, and gives attachment to the solæus, flexor pollicis, and peronæi muscles; and the anterior sharp edge to the extensor digitorum and the per-

* An anterior view of the left fibula. 1. The femoral end or head of the fibula. 2. The surface which articulates with the external tuberosity of the tibia. 3. The shaft of the fibula. 4. Its external border. 5. The internal border. 6. The lower extremity of the fibula, a rough surface which is received into the triangular concavity at the lower end of the tibia. 7. The external malleolus. 8. The surface which articulates with the astragalus. 9. A triangular, concave surface, which is subcutaneous.

† The posterior surface of the left fibula. 1. The head. 2. The pyramidal spine which surmounts the head. 3. The posterior surface of the shaft. 4. The orifice of the principal vascular canal. 5. The external malleolus. 6. The groove for the peronæal tendons.

onæi. Inferiorly this edge turns forwards and bifurcates, inclosing a triangular surface, which is subcutaneous. The *lower* or *tarsal end* is larger than the head; it is elongated into a long, oval process, the *external malleolus* or *ankle.* This is larger, longer, and more prominent than the inner ankle, descends lower, and is on a plane posterior to it; it is convex and subcutaneous externally; internally it is smooth and triangular, a little concave from behind forwards, and convex in the perpendicular direction; it articulates with the astragalus. Above this is a triangular, rough surface to articulate with the tibia. Anteriorly this process is rough, but thin, for the origin of ligaments; its posterior edge is broader, and grooved for the peronæal tendons, internal to which is a depression for the origin of the posterior external lateral ligament of the ankle-joint. From the point of this process the external lateral ligament arises; the fibula is articulated at both ends to the tibia and below to the astragalus. Ossification commences in three points.

Fig. 118.*

The *foot* is composed of twenty-six bones, which are arranged in three parts, the tarsus, metatarsus, and toes. The bones of the *tarsus* are seven: astragalus, calcaneum, navicular, cuboid, and three cuneiform, internal, middle, and external. These seven bones are arranged in two rows. The first is composed of the astragalus and os calcis, which are not placed transversely, but one above the other obliquely. The astragalus only enters the ankle-joint, from which it is directed forwards, inwards, and a little downwards. The os calcis forms the projection of the heel, and rests upon the ground; its direction is forwards, outwards, and a little upwards. The second row consists of five bones; the cuboid bone externally forms it alone, but on the inner side it presents two short transverse rows, the navicular forming the posterior and the three cuneiform bones the anterior.

The *astragalus* is next to the calcaneum in point of size; it is of an irregular twisted shape, somewhat cubical, larger above and to the outside than internally or posteriorly; is situated at the upper and middle part of the tarsus, where it is wedged between the two malleoli. Its *superior surface* presents in its two posterior thirds a large, pulley-like, articular surface, which is convex from behind forwards, and concave transversely, the reverse to the form of the end of the tibia: it is inclined a little backwards, is broader before than behind, and more prominent externally than internally. Anterior to this surface is a rough depression, the *neck* of the bone, for the insertion of ligaments. *Inferiorly* it presents two articular surfaces for the os calcis: one is posterior and external, broad and concave; the other is anterior, internal, and convex. These surfaces are separated by a deep groove, which is narrow behind, broad before, and directed forwards and outwards. Strong interosseous ligaments pass from this groove

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* The superior or dorsal surface of the left foot. 1. The calcaneum or os calcis. 2. The superior articular surface of the astragalus. 3. The anterior extremity or head of the astragalus. 4 Its external articular surface, which meets the fibula. 5. Its internal facette, which articulates with the internal malleolus. 6. The navicular or scaphoid bone. 7. The cuboid bone. 8. The internal cuneiform bone. 9. The middle cuneiform bone. 10. The external cuneiform bone. 11. The first or internal metatarsal bone. 12, 13, 14, 15. The second third, fourth, and fifth metatarsal bones. 16. The first phalanx of the great toe. 17. 17. The first phalanges of the second, third, fourth and fifth toes. 18. 18. The second or middle phalanges of the external four toes. 19, 20 20. The last or ungual phalanges of the toes.

Fig. 119.*

to the os calcis. The *posterior surface* of the astragalus is narrow, and slightly grooved in an oblique direction downwards and inwards for the tendon of the flexor pollicis; it also presents externally a pointed eminence, to which the external posterior lateral ligament of the ankle-joint is attached. The *anterior extremity* is a smooth, round head, supported by a neck, perforated by small holes for vessels; the head, directed forwards, inwards, and downwards, is articulated with the navicular bone, and rests upon the calceo-scaphoid ligament. The *external side* presents a triangular, smooth surface, concave from above downwards, and a little convex from before backwards: it is articulated with the fibula. The *inner side* is rough for ligaments, except a cartilaginous surface near the upper part, which is smaller than that on the outer side, and broader before than behind: this is articulated with the internal malleolus. Both these malleolar surfaces are continuous with the trochlea on its upper surface. It is articulated with the tibia and fibula, the os calcis, and the scaphoid.

The *calcaneum*, or *os calcis*, is the largest bone in the tarsus, at the lower and posterior part of which it is placed; it is elongated posteriorly into a process called the heel. Its *upper surface* presents two articulating surfaces to support the astragalus. The posterior is convex, broad, and directed forwards and

Fig. 120.*

outwards; the anterior is internal, narrow, and concave. These are separated by a deep, rough, transverse sulcus, into which strong ligaments are inserted; internal to this the bone is uneven, and projects into a sort of process into which the internal lateral ligament of the ankle-joint is inserted. The *inferior surface* is smaller than the superior, and is nearly flat; it presents

* The inferior or plantar surface of the left foot. 1. The posterior surface of the calcaneum or os calcis. 2. Its inferior surface. 3. Its internal surface. 4. A portion of the head of the astragalus. 5. The inferior surface of the navicular or scaphoid bone. 6. The inferior surface of the cuboid bone. 7. The internal cuneiform bone. 8. The middle cuneiform bone. 9. The external cuneiform bone. 10. The first or internal metatarsal bone. 11. The second, third, fourth, and fifth metatarsal bones. 12. The first phalanx of the great toe. 13. The second phalanges of the external four toes. 14. The second or middle phalanges. 15. The last or ungual phalanx of the great toe. 16. 16. The last phalanx of the second third, fourth, and fifth toes.

† A lateral view of the left foot, to show its arched form. 1. The calcaneum. 2. The astragalus. 3. The navicular or scaphoid bone. 4. The internal cuneiform bone. 5. The middle cuneiform bone. 6. The first or internal metatarsal bone. 7. The second metatarsal bone. 8. A portion of the upper surface of the three other metatarsal bones. 9. The sesamoid bones of the great toe. 10. The first phalanx of the great toe. 11. The first phalanges of the other toes. 12. The last or ungual phalanx of the great toe. 13. The second and third phalanges of the four other toes.

two small tubercles for the attachment of muscles and ligaments. The *posterior extremity* is slightly convex, smooth above, and covered by a bursa, and rough below for the insertion of the tendo Achillis. The *anterior extremity* is smaller, and presents an articular surface for the cuboid bone, which is concave from above downwards, and convex from side to side. *Externally* it is rather flat, being marked with two shallow grooves for the peronæal tendons, separated by a spine; into this surface the external lateral ligament of the ankle-joint is inserted. *Internally* it is broad, and hollowed out into an arch through which the flexor tendons and that of the tibialis posticus, also the plantar vessels and nerves pass. The tendon of the flexor pollicis runs in a distinct groove. At the anterior part of this surface is a prominence which supports the anterior articulation between the astragalus and os calcis: beneath it run the flexor tendons. The os calcis is attached above to the astragalus, and before to the cuboid.

The *navicular* or *scaphoid bone* is situated about the middle of the tarsus, and at its upper and internal part; of an oval form, its long axis directed downwards and inwards. Its *posterior surface* is smooth and concave, to form a superficial glenoid cavity for the head of the astragalus; the latter, however, is much larger, and projects inferiorly, in which direction it is supported by the strong, calceo-scaphoid ligament, and by the tendon of the tibialis posticus, which here generally contains a sesamoid bone. The *anterior surface* is convex, and divided by two vertical ridges into three surfaces for the three cuneiform bones; the circumference is irregular for the attachment of ligaments; internally it is rather smooth, but inferiorly it presents a tubercle into which the tibialis posticus is inserted. On its external side there is in general a small, flat, articular surface for the cuboid bone. The scaphoid is articulated to five bones, viz., the astragalus, the three cuneiform, and the cuboid; it is also connected to the calcaneum by a strong ligament.

The *cuboid bone* is situated at the outer and anterior part of the tarsus, external to the navicular and anterior to the calcaneum; although of a cubical form, it is thicker and longer internally than externally. Its *upper surface* is flat and rough, for the attachment of ligaments and muscles. The *lower surface* is irregular, rough, and tubercular behind, for the calceo-cuboid ligament, and grooved before for the tendon of the peronæus longus. Its *posterior surface* is smooth, concave transversely, but convex from above downwards. This slightly pulley-like surface is articulated with the calcaneum. *Anteriorly* it presents two articular surfaces. The internal is square, and supports the fourth metatarsal bone; the external is triangular, and supports the fifth. The *external side* is narrow, smaller than the others, and marked by the commencement of the pernoæal groove. The *internal* is rough posteriorly, but presents anteriorly two articulating surfaces, the posterior for the scaphoid, and the anterior for the external cuneiform bone. The cuboid is articulated with the calcaneum, the scaphoid, the external cuneiform, and the two external metatarsal bones.

The *cuneiform bones*. These three wedge-shaped bones are situated at the anterior part of the tarsus, between the scaphoid and the three internal metatarsal bones. The first, or the *internal*, is the largest of the three, its base is below, and its long axis is from above downwards. It is articulated posteriorly to the scaphoid bone, anteriorly to the first, and externally to the second metatarsal bone, and to the middle cuneiform; inferiorly it presents a tubercle for the insertion of the tibialis anticus, and for a portion of the tendon of the tibialis posticus. The *middle cuneiform* is the smallest, and is wedged in between the two others; its broad surface is towards the dorsum, its narrow towards the sole of the foot. It is also articulated behind to the scaphoid, and before to the second metatarsal bone. The third, or *external cuneiform* bone, is situated between the last and the cuboid bone. It is ar-

ticulated anteriorly with the third metatarsal bone; posteriorly with the scaphoid, internally with the middle cuneiform and with the second metatarsal bone, and externally with the cuboid and with the fourth metatarsal bone. All the bones of the tarsus are composed of a soft, spongy, vascular tissue, covered by a compact but thin lamina; they are each developed from one point of ossification, except the calcaneum and the astragalus, which commence each in two points.

The *metatarsus* is the second division of the foot, and consists of five long bones parallel, and separated by interosseous spaces. Its posterior border is connected to the tarsus by an irregular, transverse line of articulation; convex forwards, concave backwards. The base of the second bone, or that next the great toe, extends to a plane posterior to that on either side of it, and interrupts the regularity of this transverse line.

The *metatarsal bones* are five in number. The *first*, or internal, is the shortest and thickest, convex above, concave and sharp below; its posterior end is oval, concave, and rests on the internal cuneiform bone; the anterior end, round and smooth, supports the first or great toe. This extremity is grooved below, and lodges the sesamoid bones: the peronæus longus is also inserted into it. The *second* is the longest of the metatarsal bones; its tarsal end is wedged in between the three cuneiform bones, and is articulated to each of them. The outer side of its base is also joined to the third metatarsal bone; its anterior extremity or head is round, and supports the second toe; it is marked internally and externally by the depressions for the lateral ligaments: a groove separates the head from the body of the bone. The *third metatarsal bone* is a little shorter than the second, but of the same form; its base rests on the third cuneiform bone. The *fourth metatarsal bone* is a little shorter; it rests on the cuboid bone, and the inner side of its base also rests against the third cuneiform bone. The *fifth* is the shortest, except the first; it rests on the cuboid bone, and presents externally a styloid process, directed backwards and outwards, for the insertion of the peronæus brevis. The heads of all the metatarsal bones are round, like those of the metacarpal; the bases flat, and somewhat square, to articulate with the tarsus; the sides of their bases are also flat, to join one another. All these bones possess a similar structure, and resemble the class of long bones.

The *toes* are five in number. The first, or the great toe, has only two phalanges; all the others have three; there are, therefore, fourteen phalanges in all. The *first phalanges*, are longest; they are convex above, concave below; their posterior end is larger, and presents, as in the hand, a round concavity for the head of the metatarsal bone; the anterior end is convex from above downwards, and concave from side to side, so as to form a ginglymoid joint with the second phalanx. The *second phalanges* are very short: the great toe has none. The posterior end of each presents the trochlear surface, is a little concave from above downwards, and convex transversely, being divided by a vertical ridge: the anterior extremity is smaller than that of the first phalanx. The *third phalanges* are all very small, except that of the great toe; they are of a pyramidal form, and support the nails, their posterior extremity being very large, and similar to that of the middle phalanges; their anterior end is tubercular, and attached to the cellulo-vascular texture at the extremity of each. At the base of the first phalanx of the great toe there are in general two *sesamoid bones*, into which the small muscles of this toe are inserted; frequently, also, there is another at the base of the second phalanx; sometimes one is found at the first joint of the second toe, and another at that of the fifth

SECTION IX.

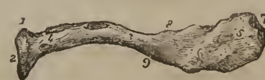
THE SUPERIOR EXTREMITIES.

Each *superior* or *thoracic extremity* consists of the shoulder, arm, forearm, wrist, and hand; the whole limb comprises thirty-two bones, the sesamoid not included. The shoulder is composed of the clavicle and scapula; the arm, of the humerus; the forearm, of the radius and ulna; the wrist, of the eight small carpal bones; the hand, of the five metacarpal and fourteen phalangeal bones.

The *clavicle* is the long bone extending from the summit of the sternum obliquely across the first rib upwards, backwards, and outwards, to the acromion process of the scapula; is curved somewhat like an italic *f*, particularly in the male; in the female it is straighter and longer, in proportion, than in the male: it presents two extremities and a body or shaft. The *sternal end* is a thick, triangular, articulating surface, inclined forwards and downwards, concave from before backwards, large above and before, small and pointed below and behind; the circumference is rough for the attachment of ligaments. The *body* is nearly cylindrical towards the sternal, but flat and expanded towards the acromial end; smooth above, and mostly subcutaneous. Inferiorly it is rough, and presents, about an inch from the sternal end, a ridge or process for the rhomboid or costo-clavicular ligament; internal to which there is sometimes a small, articulating surface, which rests on the cartilage of the first rib. External to this is a groove for the subclavian muscle. In this also is a foramen for the nutritious vessels, and near the scapular end is a tubercle and rough ridge leading outwards and forwards; to these the coraco-clavicular ligaments are attached. Its anterior edge is convex in the inner half, and gives attachment to the great pectoral muscle. The outer half is concave; to it the deltoid is attached. The posterior edge is smooth, and concave in the inner half towards the great vessels, but rough and convex externally for the attachment of the trapezius muscle. The *acromial end* of the clavicle passes over the coracoid process upwards and backwards; is flat and broad, rough above and below, and perforated by vessels; it presents at its termination a small, articulating surface for the acromion scapulæ. This surface is oval from before backwards, and cut obliquely from above and from without downwards and inwards; its aspect is outwards, forwards, and downwards, and is on a plane rather above the articulating surface of the acromion scapulæ: its circumference is rough for the attachment of ligaments. The clavicle serves to support the scapula, and to prevent it from falling too much forwards or inwards; it thereby allows it a greater freedom of motion;

Fig. 121.*

Fig. 122.†



* The superior surface of the left clavicle. 1. The internal or sternal extremity. 2. The surface which articulates with the upper piece of the sternum. 3. The body. 4. The acromial extremity. 5. The anterior border. 6. The posterior border.

† The inferior surface of the left clavicle. 1. The sternal end. 2. The surface which articulates with the upper piece of the sternum. 3. The body. 4. The ridge for the rhomboid or costo-clavicular ligament. 5. The acromial or scapular end. 6. A ridge for the attachment of the coraco-clavicular ligaments. 7. An articulating surface for the acromion scapulæ. 8. The anterior border. 9. The posterior border.

it also serves as a fixed point for certain muscles, and it protects the vessels and nerves of the upper extremity. It is articulated to the scapula and sternum, and sometimes to the cartilage of the first rib: it is very perfect in the fœtus, and is developed from a single point of ossification: it has no perfect epiphysis, although in the young subject there is an osseous crust at each extremity, which is at first separable from the rest of the bone.

Fig. 123.*

The *scapula* is situated at the upper, lateral, and posterior part of the chest, and extends from the second to the seventh rib. It is irregularly flat and triangular; it presents an internal and an external surface, three edges, and three angles. The internal or anterior surface, or *subscapular fossa*, looks towards the ribs, is slightly concave, and divided by three or four prominent lines into several broad grooves, which are filled by the fasciculi of the subscapular muscle, the aponeurosis of which is attached to those lines. The latter are not parallel to the ribs, but run obliquely upwards and forwards, while the ribs incline downwards and forwards. Above and below these is a smooth, flat surface, to which the serratus magnus is attached. The external or posterior surface, or dorsum, is convex, and divided transversely into two unequal parts by a ridge or *spine*, which commences about the upper third of the posterior border, from a smooth, polished, flat, triangular surface, over which the trapezius muscle glides: the spine then proceeds forwards, and becomes more elevated, flattened above and below, and bounded by a long, irregular, undulated margin, which is rough above for the attachment of the trapezius, and below for that of the deltoid muscle. A vascular hole is observed on its upper and under surface. This spine is a little contracted anteriorly and externally, and terminates in an eminence named the *acromion process*. This surmounts the shoulder-joint, and is about an inch above it; it is flattened in a direction contrary to that of the spine. Its external surface looks a little upwards and backwards, is convex, rather rough, and covered by the integuments. Its inferior or internal surface is smooth and concave; its upper edge is directed backwards, gives attachment to the trapezius, and presents near its termination a small and nearly horizontal, oval, articulating surface for the clavicle. The aspect of this surface is a little oblique upwards, inwards, and backwards; the lower edge gives attachment to the deltoid; its apex is rounded for the insertion of the triangular, or coraco-acromial ligament. Above the spine is the *supra-spinata fossa*, which is wider behind than before; this is filled by the supra-spinous muscle. The *fossa infra-spinata* is larger, is convex above, and concave and grooved inferiorly. Between this

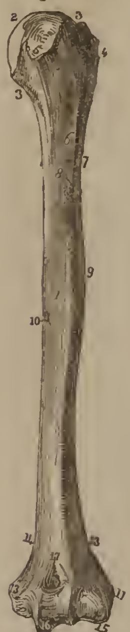
* A posterior view of the right scapula. 1. The superior border. 2. The posterior border or base of the scapula. 3. The anterior or inferior border. 4. The superior posterior angle. 5. The inferior angle. 6. The glenoid cavity which articulates with the head of the humerus. 7. The neck of the scapula: the long head of the triceps is attached to the ridge opposite the number. 8. The flat, triangular surface over which the tendon of the trapezius glides. 9. The spine of the scapula. 10. The acromion process. 11. The supra-spinous fossa. 12. The infra-spinous fossa. 13. The supra-scapular notch. 14. The coracoid process. 15. A vascular foramen for one of the nutritious arteries.

and the inferior costa is a raised surface extending from the inferior angle to the glenoid cavity. This surface is divided into two by an oblique line; the posterior portion is flat and somewhat square, and gives attachment to the teres major muscle, the anterior to the teres minor. Into the ridge between these is inserted an aponeurosis common to these two muscles. The *superior* or *cervical* border, or *costa* of the scapula, is the shortest and thinnest. At its forepart is a notch which is converted into a hole by ligament, and sometimes by bone; it is traversed by the supra-scapular nerve, and sometimes by the vessels of that name. To this costa the supra-spinatus, subscapular, and omo-hyoid muscles, are attached. From the anterior part of this border, in front of the notch, arises the *coracoid process,* which is long and narrow, and directed at first upwards and forwards, and then downwards; is convex and rough above for the attachment of the conoid and trapezoid ligaments, smooth and concave below; it overhangs the inner and upper part of the glenoid cavity; the pectoralis minor is inserted into it anteriorly, the biceps and coraco-brachialis into its summit, and the triangular ligament into its external border. The *base* of the scapula, or the posterior or vertebral edge, is the longest margin of the bone; is convex, and nearer the spine above than below: the spinati muscles adhere to its outer lip, the subscapular to its inner, and the rhomboid to its middle. About one-fourth from its upper extremity is a blunt projection formed by the smooth, triangular root of the spine. At the union of the base and upper costa is the *superior posterior angle,* which is embraced by the levator anguli muscle. The *anterior* or inferior or external or *axillary costa* is very thick, leads from the glenoid cavity, and inclines downwards and backwards. At its junction with the base it forms the *inferior angle,* on which is a long, flat surface, which gives origin to the teres major and to a few fibres of the latissimus dorsi muscle; to the upper part of it the long head of the triceps is attached. At the convergence of this and of the superior costa are the neck and the glenoid cavity. The *neck* is that contracted portion which supports the head, and is most distinct externally and inferiorly, but is accurately defined: the coracoid process is attached to the upper surface of its root. The *glenoid cavity,* or the anterior angle, is superficial, oval, broader and deeper below, covered with cartilage, and, in the recent subject, deepened by the fibrous glenoid ligament, which is partly derived from the long tendon of the biceps, which is attached to the upper extremity of the cavity: it is inclined outwards, forwards, and a very little upwards; its aspect, however, varies as the scapula is made to turn in the rotatory motions of the arm. The scapula is composed of two compact laminæ and an intervening cellular tissue; the latter prevails in the processes, in the neck, and inferior angle; in the middle of the fossa there is but little of it, and the compact substance is there thin and transparent. It is developed by several points of ossification, one in the centre of the body, one for each of the processes, one for the inferior angle, and one for the posterior or vertebral edge. It is articulated to the humerus and clavicle.

The *os humeri* is attached to the scapula above and to the radius and ulna below; is the longest and largest bone in the upper extremity, and presents two extremities and a body or shaft. The *upper* or *scapular extremity* is the larger, and consists of the head, neck, and two tubercles. The *head* is hemispherical, inclined upwards, inwards, and backwards; is smooth, and covered with cartilage for articulating with the glenoid cavity of the scapula. The *neck* is the slightly contracted line, or furrow, around the head; it is rough for the attachment of the capsular ligament, and a little longer below and before than above or behind. The axis of the neck and head forms an obtuse angle with that of the shaft. The *tuberosities* are two, the greater and lesser. The *great* or *external* presents three depressions: to the anterior of these the supra-spinous muscle is attached, to the middle the infra-spinous.

and to the inferior or posterior the teres minor. The *internal or lesser tuberosity* is also anterior; it is more prominent, and gives insertion to the subscapular tendon. Between these tubercles is the deep groove for the long tendon of the biceps, into the anterior or outer edge of which the tendon of the great pectoral is inserted, and into its posterior or inner, those of the teres major and latissimus dorsi: this groove leads downwards and inwards. Immediately above these tendinous insertions, and below the tuberosities, the bone is circular and contracted in size: this part is named the *surgical neck*, as it is a very frequent seat of fracture. The *body* or *shaft* of the humerus is thick and round above, twisted in the middle, expanded and somewhat triangular below. Its posterior surface is round above and twisted a little inwards; below it looks outwards, and is flat and broad. This surface is covered by and gives attachment to the triceps muscle; a small, vascular foramen may be observed about the centre. The anterior or internal surface is divided for about one-fourth of its length by the bicipital groove into two unequal portions, the internal of which is smooth, and presents near its centre a linear elevation for the insertion of the coraco-brachialis, in the lower part of which is an oblique vascular foramen: the brachial vessels and nerves descend along this surface. The external surface presents a long, rough eminence for the insertion of the deltoid muscle, of a V shape, and situated just below the upper third of the shaft. External to this the bone is grooved obliquely, as if twisted, for the passage of the musculo-spiral nerve and artery. This groove leads from the upper and posterior aspect of the bone at first downwards and outwards, and next downwards and forwards, to the forepart of the external intermuscular ridge. These surfaces of the humerus are separated by two prominent lines, one is external and anterior, the other is internal and posterior: these lines are more distinct below than above; they give attachment to the intermuscular ligaments, and lead down to either condyle. The external is interrupted about the middle by the musculo-spiral groove, but is very prominent below, curved forwards, and gives attachment to the brachiæus anticus, the supinators and extensors, the triceps, and the external intermuscular ligament. On the anterior surface of the humerus there is also a prominent line continued from the anterior edge of the bicipital groove; it is gradually flattened below, and covered by the brachiæus anticus muscle. The *lower extremity* of the humerus is flattened, elongated transversely, and twisted a little forwards. It presents internally the *internal condyle*, which is very prominent, and turned somewhat backwards: this gives attachment to the common tendon of the pronators and flexors and to the internal lateral ligament of the elbow-joint. Externally is the *external condyle*, not so prominent as the internal, and situated lower down; it gives attachment to the external lateral ligament and to the supinator and extensor muscles. Between and below these condyles is a series of articulating eminences and depressions, partly turned forwards; they consist of externally a *small round head*, which

Fig. 124.*



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* The anterior surface of the left humerus. 1. The body or shaft. 2. The head. 3. The neck. 4. The great tuberosity. 5. The lesser tuberosity. 6. The bicipital groove. 7. The anterior or outer edge of the bicipital groove. 8. Its posterior or inner edge. 9. The rough surface for the insertion of the deltoid muscle. 10. A foramen for a nutritious artery. 11. The external condyle. 12. The internal condyle. 13. The external condyloid ridge. 14. The internal condyloid ridge. 15. The capitulum or small head for articulation with the radius. 16. The trochlea for articulation with the ulna. 17. The coronoid fossa.

articulates with the head of the radius, internal to which is a slight depression corresponding to the margin of the radius. Internal to this is a sharp, semicircular ridge, extending round the lower end of the bone from behind forwards and from without inwards, separating the radius and ulna. Next to this is the *trochlea* for articulation with the ulna; this also leads from behind forwards and from without inwards; its inner border is lower than the outer, and the whole is so much below the level of the small head, and of the outer portion of the articular surface, as to give the whole bone an oblique direction outwards when its lower end is placed on a horizontal plane. At the anterior extremity of this trochlea is a small depression for the reception of the coronoid process in flexion of the joint; and at the posterior is a large fossa which lodges the olecranon process in the extended state of the forearm. The bone between these depressions is thin and transparent, and sometimes deficient from absorption, in which case the two processes of the ulna nearly approximate, and are locked in the humerus. The humerus, like the femur, is of the compact structure in its body, and of the cellular in its extremities; it contains a large medullary canal, and is developed from eight points of ossification, one for the head, one for each tuberosity, one for the shaft, one for the trochlea, one for the small head, and one for each condyle: the bone consists of three pieces to the age of twenty; the shaft and two epiphyses; the upper epiphysis includes the head and the two tuberosities, with a portion of the bicipital groove, and is separated from the shaft by a well-defined line, which, internally, is immediately below the cartilaginous border of the head, but in the rest of its circumference is below the tubercles; this line is not unfrequently the seat of fracture or separation: it is inferior to the anatomical neck, or the narrow oblique line between the head and tubercles, into which the capsular ligament is inserted; in this line also fracture occasionally occurs; and will be found to be within the capsule, whereas a fracture in the epiphysary line will be extra-capsular, as of course that also of the surgical neck of the bone.

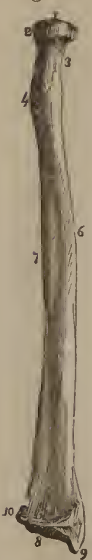
Fig. 125.

The *ulna* is situated at the inner side of the forearm, forms the principal portion of the elbow, but does not directly enter into the wrist-joint; is longer than the radius at the upper end, but falls a little short of it below; it is divided into the body and two extremities. The *upper extremity* is larger than the lower, and presents two processes and an intervening cavity. The posterior process, or the *olecranon*, is the highest part of the bone; its superior border gives attachment to the triceps extensor: posteriorly it presents a smooth, triangular surface, covered by skin and by a bursa; anteriorly it is concave, and covered with cartilage. The *coronoid process* is anterior and inferior to the preceding; anteriorly it gives insertion to the brachialis anticus muscle, internally to the flexors and pronators and to the internal lateral ligament, and externally it is hollowed out into the *lesser sigmoid cavity*, which receives the border of the head of the radius; this small cavity is oval, its long diameter being from before backwards; it leads superiorly into the *great sigmoid cavity*, which moves on the trochlea of the humerus in flexion and extension of the forearm: this sigmoid cavity resembles the letter C, if viewed in profile; its posterior vertical portion is larger than the anterior, which is horizontal; it is divided by a middle ridge into two lateral portions, of which the internal is the larger; these are each again divided by a transverse furrow, which ends in a notch at either margin: this surface is all covered with cartilage, except the furrow, in which

* The anterior view of the left ulna. 1. The olecranon process. 2. The great sigmoid cavity. 3. The coronoid process. 4. The lesser sigmoid cavity. 5. The anterior surface of

some fatty matter is lodged. The *body* of the ulna is divided into three surfaces by three lines; these surfaces are larger above than below. The anterior is slightly grooved for the flexor profundus, and presents superiorly a vascular foramen directed obliquely upwards. The internal surface is broad and concave above, and covered by muscles; below it is round and subcutaneous. The posterior surface is irregular; it is divided into two portions by a prominent line. Of these the superior and internal is broad, and gives attachment to the anconæus. The inferior and outer portion is long and narrow, and covered by the extensors of the thumb. The anterior edge is round, and gives insertion to the flexor profundus and pronator quadratus; the posterior edge is very distinct above, and gives attachment to an aponeurosis common to the flexor profundus and flexor and extensor carpi ulnaris; the external edge is sharp for the three superior fourths, and gives attachment to the interosseous ligament. The *lower* or *carpal end* of the ulna is small and round, and presents two eminences. The external is named the *head;* is round, and covered with cartilage, and received into the cavity in the inner border of the radius, and is contiguous inferiorly with the fibro-cartilage of the wrist, which separates it from the cuneiform bone and from the carpal articulation. The internal eminence, or the *styloid process*, is more prominent, and on a level with the posterior surface of the bone; it is conical, elongated, and a little everted; it gives attachment to the internal lateral ligament of the wrist. These eminences are separated posteriorly by a groove for the tendon of the extensor carpi ulnaris, and inferiorly by a depression for the insertion of the triangular fibro-cartilage. The ulna is articulated above to the humerus and radius, and below to the radius and inter-articular cartilage: it is developed from three points of ossification, one for the shaft and one for each extremity.

Fig. 126.*



The *radius* is shorter than the ulna by the length of the olecranon. It is situated at the outer and anterior part of the forearm, is larger below than above, is curved about the centre, and is convex outwards and backwards; it is the principal bone in the carpal joint, but only accessory as a rotatory bone in the elbow. It is divided into the body and two extremities; the *upper* or *humeral end* presents a head, neck, and tubercle. The *head* is a circular, superficial cavity; its surface and circumference covered with cartilage, the former to articulate with the small head of the humerus, and the latter with the sigmoid cavity of the ulna and with the annular or coronary ligament. The internal or ulnar portion of the circumference is broader than the external. The *neck* is near an inch long, descends obliquely inwards, is contracted and circular. At its lower and inner extremity where it joins the shaft, is the *tubercle*. This process is directed backwards and inwards; into its inferior and posterior rough surface the tendon of the biceps is inserted: anteriorly it is smooth and covered by a bursa. The *body* or shaft of the radius is somewhat triangular, and presents three surfaces separated by three margins or angles. The anterior surface is broad below, and cov-

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the shaft. 6. The nutritious foramen. 7. The external edge which gives attachment to the interosseous ligament. 8. The small round head at the carpal extremity of the ulna. 9. The styloid process of the ulna. 10. A depression for the insertion of the interarticular fibro-cartilage.

* The anterior surface of the left radius. 1. The head of the bone. 2. The smooth border for articulating with the lesser sigmoid cavity of the ulna and with the annular or coronary ligament. 3. The neck. 4. The tubercle. 5. The body or shaft. 6. The rough surface for the insertion of the pronator teres. 7. The internal edge to which the interosseous ligament is attached. 8. The lower or carpal extremity of the bone. 9. The styloid process of the radius. 10. The surface which receives the lower extremity of the ulna.

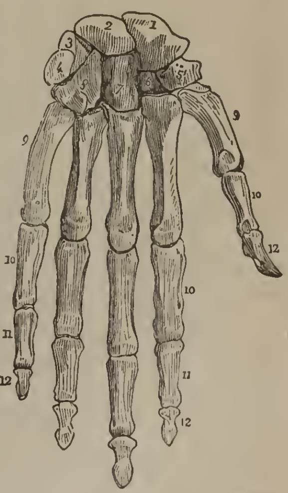
ered by the pronator quadratus; narrow above, where it gives attachment to the flexor pollicis; about one-third from the head is the orifice of the vascular canal, slanting obliquely upwards. The posterior surface is convex above, and covered by the supinator brevis; concave in the middle for the extensors of the thumb, and convex below. The external surface is round and convex, and presents near the centre a rough surface for the insertion of the pronator teres. Of the angles, or edges, the inner is most distinct; it is sharp, and gives attachment to the interosseous ligament. The lower or *carpal end* of the radius is irregularly square, broader internally than externally; its anterior prominent edge gives attachment to the anterior carpal ligament. Posteriorly it presents three grooves for the extensor tendons. One nearly in the middle line, narrow and oblique, lodges the tendon of the extensor secundi internodii pollicis; the second is at the ulnar side of this, is broad, and transmits the tendons of the extensor communis and indicator; and the third, which is to the radial side of the first, is divided in o two for the tendons of the extensor carpi radialis, longus, and brevis. Along the external border is another groove leading downwards and forwards, and divided into two for the extensor ossis metacarpi and primi internodii pollicis. The border between these two last grooves is prolonged down into the *styloid process*, from the point of which the external lateral ligament of the wrist arises. The supinator longus tendon is attached to its base and to the bone above it. On the internal border is an oblong, smooth cavity, to receive the lower end of the ulna. Inferiorly the radius presents an articular surface, divided by a line from before backwards into two unequal portions. The external is large and triangular, and meets the scaphoid bone; the internal is smaller, somewhat square, and meets the lunar bone. The radius, like other long bones, is of a cancellated structure at each extremity, and compact in the centre, where it also contains a medullary canal, which is larger above than below. It is developed from three points of ossification, one for the shaft and one for each extremity.

The *hand* consists of the carpus, metacarpus, and fingers; twenty-seven bones in all.

The *carpus* is composed of eight bones, arranged in two rows. The *first row* consists of the scaphoid, lunar, cuneiform, and pisiform; the *second* of the trapezium, trapezoid, magnum, and unciform; enumerating them from the radial to the ulnar side, or from without inwards.

The *scaphoid* or *navicular* is the largest in the upper row, at the radial or outer side of which it is situated. It presents four articular surfaces; it is elongated and convex on the upper or radial surface, adapted to the external depression on the end of the radius. The inferior surface, directed a little outwards and backwards, is triangular, smooth, and concavo-convex, to articulate with the trapezium and trapezoid. Into the posterior narrow surface ligaments are inserted. To the external or radial side the external lateral liga-

Fig. 127.*



* The anterior or palmar surface of the bones of the hand. 1. The scaphoid or navicular bone. 2. The lunar. 3. The cuneiform. 4. The pisiform. 5. The trapezium. 6. The trapezoid. 7 The os magnum. 8. The unciform. 9. 9. The five metacarpal bones. 10. 10. 10. The first row of phalanges, five in number. 11. 11. The second or middle row of phalanges, four in number. 12. 12. 12. The last or ungual phalanges, five in number.

ment is attached. The inner or ulnar side presents two smooth, articulating surfaces; one superior, narrow, to articulate with the lunar bone; the other inferior, large, and concave, to articulate with the head of the magnum; it thus meets five bones.

The *lunar* or *semicircular bone* is smaller than the scaphoid. It presents four articulating surfaces; smooth and convex above to meet the radius, concave below to articulate with the magnum and unciform; its ulnar side is flat to meet the cuneiform, and its external to meet the scaphoid; its anterior surface is larger than its posterior, and projects a little into the palmar arch. It is articulated to five bones.

The *cuneiform* or *pyramidal bone*. The base of this wedge-shaped bone looks outwards, and articulates with the lunar; the apex is inwards; it is convex and smooth above to meet the carpal fibro-cartilage; concave and smooth below to articulate with the unciform bone; rough posteriorly and internally for ligaments. Anteriorly it presents a flat, circular, cartilaginous surface for the pisiform bone. It is articulated to three bones and to the fibro-cartilage.

The *pisiform bone*. This small, pea-shaped bone is the smallest in the carpus, at the upper and inner part of which it is placed; it is also on a plane anterior to the first row; it is articulated to the cuneiform bone by a small, circular surface; its circumference is rough for the attachment of ligaments; the flexor carpi ulnaris is inserted into it above, and the abductor minimi digiti below.

The *trapezium* is the most external of the second row of the carpus; it is concave above to meet the scaphoid, below it is convex from behind forwards, and concave transversely, to support the metacarpal bone of the thumb by a pulley-like surface; anteriorly it is marked with a groove for the tendon of the flexor carpi radialis; internally it is articulated to the trapezoid, and beneath this by a small surface to the second metacarpal bone. It joins four bones.

The *trapezoid* is of a very irregular shape, and smaller than the trapezium; above it is smooth and concave to meet the scaphoid; externally it articulates with the trapezium, internally with the magnum, and inferiorly with the second metacarpal bone. It joins four bones.

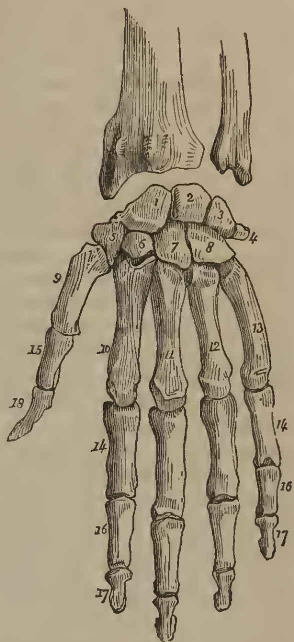
The *os magnum* is the largest of the carpal bones. It presents superiorly a round and hemispherical head, which is received into the socket formed by the scaphoid and lunar bones; this head is supported by a contracted neck; its greatest convexity is turned backwards and outwards. The inferior surface of the magnum is divided into three articulating surfaces; these support the second, third, and fourth metacarpal bones: that for the third is the largest, and for the fourth the smallest. Its posterior surface is broad and convex below, and a little concave above; externally it joins the trapezoid, and internally the unciform; both anteriorly and posteriorly it gives attachment to ligaments. It articulates with seven bones.

The *unciform bone* is next in size to the os magnum. It is situated at the lower and inner part of the carpus, is rather wedge-shaped, the base below, articulated with the fourth and fifth metacarpal bones; its upper surface is narrow, and meets the semilunar bone; its external side joins the magnum, its internal the cuneiform; its posterior surface is rough for ligaments. From its anterior projects a small hooked process, curved outwards for the attachment of the annular ligament and for some of the muscles of the little finger. It articulates with five bones. All the bones of the carpus, like those of the tarsus are composed of a spongy, vascular tissue, invested by a thin, compact lamina; they are developed each from a single point of ossification, except the unciform, which has two: the pisiform is the latest to ossify.

The *metacarpal bones* belong to the class of long bones. They are five in

number, are placed nearly parallel to each other, exept the first, or that of the thumb, which is on a plane anterior to the others, and is thick and short; the third is the longest. They are all concave on the palmar surface, convex on the dorsal, and large at each extremity. The *posterior end* is of an irregular figure; the *anterior* presents a round head. The *palmar surface* of each is narrow, and presents a median prominent line. The *posterior surface* of the first is convex, but on the second, third, and fourth, it presents a prominent longitudinal line, which bifurcates and forms the sides of a flat, triangular surface, extending for near two-thirds of their length. Into their edges the interossæi muscles are inserted. The dorsal surface of the fifth is divided by an oblique line diagonally; the outer portion is concave, and lodges the fourth interosseous muscle; the inner convex and broad, is covered by the extensor tendon of the little finger. The carpal end or base of the first is concave from before backwards, and convex transversely, to articulate with the trapezium; the base of the second is concave, and articulates with the trapezoid, and presents also externally a small, smooth surface for the trapezium, and internally two smooth surfaces, one for the magnum, the other for the base of the third metacarpal. The base of the third is nearly plane, and rests on the magnum, and presents on either side articulating surfaces for the contiguous metacarpal bones. The base of the fourth presents two articulating surfaces, one for the magnum and one for the unciform; on the radial side two. and on the ulnar side one articulating surface for the adjacent metacarpal bones. The base of the fifth presents a concave surface, directed outwards to articulate with the unciform; its radial side articulates with the base of the fourth metacarpal bone. The anterior or digital ends of all the metacarpal bones are convex; their smooth surfaces are broader, and extend further on the palmar than on the dorsal surfaces of each. They are articulated with the bases of the first phalanges; they are flattened at the sides for the attachment of ligaments.

Fig. 128.*



The *fingers* are composed each of three phalanges, except the thumb, which has only two: there are fourteen phalanges in all. The *first*, or those

* The posterior or dorsal surface of the bones of the hand, comprising the carpus, metacarpus, and fingers. 1. The scaphoid or navicular bone, articulating with five bones. 2. The lunar or semilunar, articulating with five bones. 3. The cuneiform, articulating with three bones and with the triangular fibro-cartilage. 4. The pisiform, articulating with the cuneiform only. 5. The trapezium, articulating with four bones. 6. The trapezoid, articulating also with four bones. 7. The os magnum, articulating with seven bones. 8. The unciform, articulating with five bones. 9. The first metacarpal bone, articulating by its carpal end with the trapezium only. 10. The second metacarpal bone, articulating by its base with four bones. 11. The third metacarpal bone, articulating by its base with three bones. 12. The fourth metacarpal bone, articulating by its base with four bones. 13. The fifth metacarpal bone, articulating by its base with two bones. 14. 14. The first row of phalanges. 15. The first phalanx of the thumb. 16. 16. The second row of phalanges. 17. 17. The third or ungual phalanges. 18. The last or ungual phalanx of the thumb.

next the metacarpus, are the largest; the *third* are the smallest; the second, or middle, are of an intermediate size. The metacarpal, or the first phalanges, are five in number. The base or posterior end of each presents a cavity transversely oval for the head of the metacarpal bone; the anterior extremity of each presents two small condyles separated by a groove; these are prolonged anteriorly, and articulate with the second or middle phalanx. The anterior surface of each is arched from before backwards, hollowed from side to side to lodge the flexor tendon, the sheath of which is attached to its lateral edges; the posterior surface is convex and arched. The *second* or middle phalanges are four in number; they are smaller than the first. The base of each presents two small cavities and a middle ridge, or a pulley-like surface, to articulate with the first, with which it forms a ginglymoid joint. About the centre of their anterior surface is a rough depression for the insertion of the tendon of the flexor sublimis. The anterior or digital extremity of each resembles the anterior end of the first phalanx, and is convex from before backwards, and concave from side to side, the two articulating condyles being prolonged on the palmar further than on the dorsal surface, so as to increase the extent of flexion. The thumb wants this second phalanx. The *third* or last, or *ungual phalanges*, are five in number; they are the smallest, and somewhat of a pyramidal form. The base articulates with the second phalanx, and presents a pulley-like surface, having two small cavities and a middle-ridge, such as the base of the second phalanx. Their posterior surface, convex, supports the nail; their anterior is rough, and irregularly concave for the attachment of the flexor tendon and ligaments; its anterior extremity or apex is irregularly tuberculated to support the extremity of the finger. The phalanges in structure resemble metacarpal bones: the last, or the ungual, are more cellular, and have no medullary canal: they are developed each from two points of ossification, one for the shaft and one for the anterior extremity. The posterior end is continued from the shaft.

On the forepart of the articulation, between the metacarpal bone and the first phalanx of the thumb, there are generally two *sesamoid bones*, and sometimes one in the corresponding joint of the index finger. These bones, like those in the foot, as well as in other situations, where they are occasionally found, as behind the condyles of the femur, in the heads of the gastrocnemii muscles, &c., do not properly belong to the osseous system; they are rather accessories to the tendons of muscles; they are found in the limbs only, and generally in the direction of flexion. They are developed from cartilage, which is deposited in tendinous or ligamentous structure, and which is very slow to ossify. The patella has some resemblance to bones of this class; it is, however, more perfect, and is placed on the aspect of extension. The sesamoid bones serve to strengthen the articulations to which they are attached; they also increase the power of the muscles, by altering the direction of their tendous and removing them further from the axis of the bone which they are intended to move.

Os Hyoides.—For the description of this bone *see* Dissection of the Larynx, p. 53.

Fig. 129.*

* The anterior view of the os hyoides. 1. The anterior convex surface of the body. 2. 2. The greater cornua. 3. 3. The appendices or lesser cornua.

CHAPTER II.

DISSECTION OF THE JOINTS.

SECTION I.

GENERAL OBSERVATIONS.

When all the muscles, vessels, nerves, &c., have been dissected, the student may examine the anatomy of the joints, the study of which is termed *syndesmology* or *arthrology.* Different sections of these should be made, and, when the principal short parts are removed, they should be subjected to maceration for some days. The several parts of the osseous system, when connected either by natural or artificial media, constitute the skeleton. The attachment between two or more bones is denominated an articulation or a joint, of which there are great varieties in the frame; they may, however, all be reduced to three classes, the movable or diarthrosis, the immovable or synarthrosis, and the mixed or amphiarthrosis.

1. Diarthrosis, or the movable, includes all the perfectly movable joints, and presents three species, viz.: *enarthrosis, arthrodia,* and *ginglymus.* The first resembles the ball and socket, of which the hip and shoulder are the best examples. The second is a modification of the first, the surfaces being nearly plane, and the motion more limited. The articulations between the oblique processes of the vertebræ, those between the bodies of the latter and the heads of the ribs, and many others to be noticed hereafter, are examples. The third is the hinge or trochlea, and is more complex, the motion being limited to two directions, forwards and backwards, or flexion and extension, as in the articulations of the elbow and knee, and between the phalanges of the fingers and toes. In these motions the axis of the hinge is transverse; there are other joints, however, which may be considered ginglymoid, the axis being vertical, like the hinge of a door, as the odontoid process of the second vertebra within the ring formed by the atlas and its transverse ligament, also the head of the radius within the coronary ligament and the lesser sigmoid cavity of the ulna; some, however, consider these as pivot joints, others as arthrodial.

2. Synarthrosis, or the immovable, includes three species, viz.: *suture, gomphosis,* and *schindylesis. Suture* is the serrated interlocking observable between the bones of the head and face. In most instances the opposed edges are indented like the teeth of a saw; in some few they meet by rather plane surfaces (harmonia), and in others they are scaly, and one overlaps the other (squamous suture). Although the bones are very intimately connected together in these lines, yet there is always a fine membrane interposed, which is continuous with the periosteum on either surface. *Gomphosis* is seen in the connection between the teeth and their sockets, and *schindylesis* between the vomer and the other parts composing the septum narium.

3. Amphiarthrosis, or the mixed, include those cases in which the bones are connected by an intervening fibrous or fibro-cartilaginous substance, and enjoy very different degrees of mobility, in some being free and obvious, as between the bodies of the vertebræ; in others very much restricted, and al-

most inappreciable, as in the pubic and ileo-sacral symphisis, and between the different portions of the sternum. In these latter examples the bones are so closely attached and fixed that *symphisis* is arranged by some writers under synarthrosis, or the immovable articulations. The joints present such variety of form and such modification of structure, in order to effect security and strength, as well as to admit of motion or yielding, in such varied degrees, that many of them exhibit mixed characters, or combine in one the properties of several; hence no arrangement or classification of the articulations can be critically correct.

All the movable articulations include several structures differing in use and organization, viz., the extremities of two or more bones; these are covered by cartilage; a synovial membrane, covered by a fibrous capsule, or strengthened by accessory ligaments and fascia. Some joints also contain interarticular cartilages and ligaments, also reddish vascular adipose masses. The articular, or incrusting cartilages, adhere almost inseparably to the ends of the bones; they are smooth and elastic, composed of fibres which are placed perpendicular to the bone; they are thickest on the most convex part of the heads of bones and on the circumference of the articular cavities (page 556).

The *interarticular cartilages,* or *fibro-cartilages,* are very elastic; the fibrous tissue in some of them is very evident. Many of these are attached to the circumference of the cavities forming the *glenoid* or *cotyloid* ligaments, which serve to deepen the cavity, and to prevent the hard edges of the bones striking against each other. Some interarticular cartilages are movable, as in the temporo-maxillary and knee-joints: all these bodies serve either or deepen the cavities, or to attach the bones more closely, or to lessen shocks.

Synovial membranes of joints are very thin sacs, similar to the bursæ, allied also to the great serous membranes, inasmuch as they exhale and absorb a fluid, and are shut bags without any opening; they are, on the whole, however, more vascular and less elastic than the true serous membranes; the synovia also, or the fluid which the former secrete, is a glairy, unctuous-feeling fluid, albuminous and alkaline, and different from the fine, watery exhalation of the latter. Every synovial membrane lines the fibrous capsule or accessory coverings; is thence reflected over the interarticular cartilages or ligaments when present, and over the articular or incrusting cartilages, and in some cases over portions of the bones themselves. On the cartilages the membrane is so fine and delicate as to be incapable of perfect demonstration, except under the influence of maceration or disease. By the assistance of the microscope, however, a fine tesselated epithelium has lately been discovered on the surface of articular cartilage, similar to that on the parietal portion of the membrane. In some articulations the synovial membrane is complicated in its arrangement, being folded round tendons or ligaments, as in the hip and shoulder, or thrown into processes which contain fat and vessels, so as to resemble a vascular or glandular mass. Such exists in the knee and in many other joints, and have been improperly considered glands or follicles by Havers and others.

Ligaments are important appendages to joints, and present great variety as to structure and arrangement; they are principally composed of the white fibrous, but in some situations of the yellow or elastic tissue. The former consists of white, glistening bands or fasciculi, tough, unyielding, and inelastic, the fibres arranged either in parallel lines, as in the lateral and transverse ligaments, or interwoven in every direction, as in the capsular.

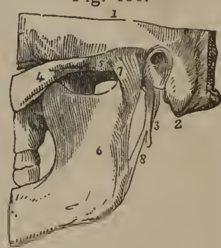
SECTION II.

TEMPORO-MAXILLARY ARTICULATIONS.

These are examples of double arthrodia; they have also some of the characters of ginglymus, and are, therefore, denominated by some double arthrodial ginglymoid joints. Each condyle of the inferior maxilla, being received into that portion of the glenoid cavity of the temporal bone which is anterior to the fissure, can also move on the transverse root of the zygoma. Each maxillary condyle is transversely oval, and directed inwards and backwards, so that their axes, if produced, would meet posteriorly. The transverse eminence of each zygoma is in a parallel line to each condyle, is convex from before backwards, and concave transversely, and covered by cartilage. Only the anterior portion of each glenoid cavity is articular, and covered by cartilage. The Glasserian fissure which limits it posteriorly is directed transversely inwards and forwards, and, if these fissures be produced, they would meet anteriorly; hence the articular cavity is somewhat triangular, wide externally, narrow internally. These joints are strengthened by an external and internal lateral, an inter and stylo-maxillary ligament, and by an imperfect but rather strong capsular ligament, which contains an interarticular cartilage and two synovial membranes.

The *external lateral ligament* is short and narrow; it arises from the tubercle at the junction of the two roots of the zygomatic process of the temporal bone, descends obliquely backwards, and is *inserted* narrow into the outer side of the neck of the condyle of the lower jaw: it is covered by the skin and the parotid gland, and it adheres to the capsular ligament, of which it seems to be but a thickened fasciculus.

Fig. 130.*



The *internal lateral ligament* is thinner and longer than the external; it *arises* narrow from the spinous process of the sphenoid bone, descends obliquely forwards, and is *inserted* broad into the inner margin of the orifice of the inferior dental canal. Its insertion is pierced by the mylo-hyoid nerve. This aponeurotic band corresponds externally to the capsule and to the external pterygoid muscle above, and lower down to the internal maxillary vessels, and to the dental vessels and nerve which intervene between it and the bone. Its inner surface rests on the internal pterygoid muscle, which it thus bears off from compressing the dental nerve and vessels. It is not properly a ligament to the articulation, although a few of its deep fibres adhere superiorly to the capsule: these latter are by some named *short internal lateral* ligament.

Fig. 131.†

The *intermaxillary ligament* scarcely deserves the name of ligament; it is rather a dense, vertical, aponeurotic band, common to the buccinator and superior constrictor of the pharynx; attached *above* to the external pterygoid process and adjacent surface

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* An external view of the temporo-maxillary articulation of the left side. 1. A part of the squamous portion of the temporal bone. 2. The mastoid process of the temporal bone. 3. The styloid process of the temporal bone. 4. The zygomatic arch. 5. The tubercle at the root of the zygoma. 6. The ramus of the lower jaw. 7. The external lateral ligament. 8. The stylo-maxillary ligament.

† An internal view of the temporo-maxillary articulation. 1. A vertical section through

of the superior maxillary bone, and *below* to the root of the coronoid process of the inferior maxilla.

The *stylo-maxillary ligament* is a thin aponeurosis which *arises* from the styloid process of the temporal bone, passes forwards and outwards; is connected to the cervical fascia and to the stylo-glossus muscle, and is *inserted* into the angle of the lower maxilla, between the masseter and internal pterygoid muscles, and between the parotid and submaxillary glands. This ligament, like the last mentioned, does not properly belong to the articulation; it is rather intended to strengthen the cervical fascia and to increase the surface of attachment for the stylo-glossus muscle.

The *capsular ligament* consists of dense fibres which *arise* from the anterior margin of the transverse zygomatic eminence and from the glenoid fissure. As they descend they *adhere* to the synovial membranes and to the interarticular cartilage, and are *inserted* into the neck of the lower jaw. This ligament is covered posteriorly by the parotid gland and adipose substance; externally and internally by the lateral ligaments, and in part by the external pterygoid muscles. It is deficient at the anterior and internal part to admit the insertion of the external pterygoid into the interarticular cartilage and into the neck of the bone; it is wider above than below, and it is prolonged very low down upon the bone behind.

Fig. 132.*

The *synovial membranes*, one superior and larger, covers the cartilaginous surface of the zygomatic eminence and the articular portion of the glenoid cavity, and is reflected over the upper surface of the interarticular cartilage; the other, the lower and smaller, covers the under surface of the interarticular cartilage, and is reflected over the condyle on which it is prolonged lower down posteriorly than in front. These sacs have no communication with each other, unless, as is sometimes the case, there should be a small foramen in the centre of the cartilage.

The *interarticular fibro-cartilage* is transversely oval, thick in its circumference, thin in the centre. Its upper surface is adapted to the articular eminence and to the forepart of the glenoid cavity, being concave before and convex behind, and its lower surface, which is smaller, fits on the condyle. Some fibres of the external pterygoid are attached to its inner and forepart; the capsular and external lateral ligament also adhere to it; sometimes there is a hole in the centre of it through which the synovial membranes communicate. This cartilage is composed of very close, concentric fibres, which are more distinct at the circumference; it has no direct attachment to bone, as the interarticular cartilages in some joints, and therefore it partakes less of the fibrous structure; it serves to strengthen the articulation, and thus to guard against displacement, by presenting to the condyle a movable socket, which prevents it slipping off the articular eminence of the temporal bone, on which

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the basilar process of the occipital bone. and through the body of the sphenoid bone, showing (2) a portion of the sphenoid sinus. 3. The internal surface of the petrous portion of the temporal bone. 4. The mastoid process. 5. The styloid process. 6. The internal surface of the ramus of the lower jaw. 7. The orifice of the inferior dental canal. 8. The internal portion of the capsular ligament. 9 The internal lateral ligament. 10. The stylo-maxillary ligament. 11. The pterygoid process of the left side.

* The temporo-maxillary articulation. In this view the external lateral ligament has been removed. the interarticular fibro-cartilage, and two synovial membranes, divided by a vertical section, and the condyle of the lower jaw drawn downwards out of the glenoid cavity, in order to show the disposition of the internal structures of the joint. 1. The zygomatic arch. 2. The ramus of the lower jaw. 3. The styloid process. 4. The stylo-maxillary ligament. 5. The left condyle of the lower jaw. 6. The outer extremity of the transverse root of the zygoma, or eminentia articularis. 7. The superior synovial membrane. 8. The interarticular fibro-cartilage. 9. The inferior synovial membrane.

the condyle rests every time the mouth is fully opened, for this joint presents the rare example of one convex body being occasionally opposed to another: this cartilage also serves to lessen friction in the joint, as well as the effects of pressure and concussion.

The motions of the lower jaw are not very conspicuous at the articulations, but are considerable towards the forepart of the bone. This can be depressed, elevated, moved backwards, forwards, and towards either side. In depression of the chin, the condyles, together with the interarticular cartilages, advance and descend a little, so as to rest on the transverse roots of the zygomatic processes; in elevation the condyles are behind these roots in the glenoid depressions; in rotation the condyles move alternately, one being the fixed point for the other; thus, in moving the chin to the right side, the right condyle is fixed in the glenoid cavity, while the left advances and descends a little, and the contrary state occurs in moving the chin towards the left side. These motions occur rapidly and alternately in masticating or grinding the food; they have been explained in the chapter on the muscles, (p. 33.)

The condyles of the lower jaw are very liable, one or both, to dislocation: this can only occur in the anterior direction. When both condyles are thus displaced, there is a perfect dislocation; when only one condyle, it is a partial dislocation. In the perfect form the mouth is opened, and cannot be closed, as the coronoid process strikes against the malar and maxillary bones; the incisor teeth of the lower jaw are on a plane anterior to those of the upper, and their edges are directed rather forwards. There is also a depression in front of each ear, and the temporal muscles seem elongated; articulation and deglutition are much impaired. When the partial dislocation occurs, the chin is turned a little towards the opposite side, and the other symptoms exist in a less marked degree. Dislocation of this bone, either perfect or partial, is caused by the spasmodic action, not merely of the depressing muscles, but principally of the external pterygoid, assisted by the internal pterygoid and the superficial lamina of the masseter. When the mouth is wide open, we can readily conceive how those muscles, particularly the external pterygoid, can draw forwards the condyles from off the articular eminences of the zygomatic processes into the temporal fossæ, under the zygoma, and place them between this arch and the temporal muscle. In general but little injury is inflicted on any of the ligaments of the articulation; the internal lateral and part of the capsule may be lacerated; the elevator muscles are tense, also the intermaxillary ligament; the external pterygoid and the depressors are relaxed. Dislocations of this bone cannot occur in the child under four years of age, in consequence of the peculiar form of the jaw, the angle being so obtuse, and the ramus directed so obliquely forwards and downwards.

SECTION III.

ARTICULATION OF THE OCCIPUT WITH THE ATLAS.

This is a double arthrodia, the condyles of the occipital bone being received into the superior oblique processes of the atlas. The former, oval and convex, look downwards and outwards, and converge anteriorly; the latter correspond to these in size and shape, and look upwards and inwards. These joints are secured by capsular ligaments and synovial membranes, which cover the opposed cartilaginous surfaces. The anterior and posterior arches of the atlas, and its transverse processes, are also attached to the occipital bone, by an anterior and posterior and two lateral ligaments.

Fig. 133.*

The *capsular ligament* on each side *arises* from the circumference of the condyle, and is *inserted* into that of the glenoid cavity of the atlas. These ligaments are sufficiently loose to allow of slight motion, and are strong anteriorly and externally. The *synovial membranes* line the interior of each capsule, and are reflected over the opposed cartilaginous surfaces of the condyle and the cavity.

Anterior and *posterior occipito-atlantal ligaments arise* from the edges of the foramen magnum, and are *inserted* into the upper border of the atlas, before and behind its oblique processes. The *anterior* consists of two portions, one is superficial, a strong, round fasciculus, extending from the basilar process to the tubercle on the atlas; the deep portion is broad and thin, and passes from the forepart of the foramen magnum to the anterior ring of the atlas; it rests on the odontoid process and its ligaments, and is covered by the recti antici minores. The *posterior* is broad, but thin and weak; adheres to the dura mater, and is pierced on either side for the vertebral vessels and suboccipital nerves; it is covered by the posterior lesser recti and inferior obliqui muscles.

Fig. 134.†

The *lateral ligaments* are strong cords extending from the transverse processes of the occipital bone to those of the atlas; they are continuous with the sheaths of the great vessels and nerves at the base of the skull. In these arthrodial articulations no horizontal rotatory motion can occur; flexion and extension, or a forward and backward movement of the head, and a very slight lateral flexion, or what are termed the "nodding motions" of the head, can alone take place.

SECTION IV.

ARTICULATION OF THE OCCIPUT WITH THE AXIS OR SECOND VERTEBRA.

The occipital bone, though not in contact with, is yet connected to the axis by the lateral or moderator ligaments, one on each side, and by the apparatus ligamentosus colli in the middle: this may, therefore, be considered as examples of amphiarthrosis or syndesmosis. To expose these ligaments, the laminæ and spinous processes of the four or five superior cervical vertebræ

* An anterior view of the ligaments connecting the occipital bone, the atlas, and the axis. 1. A transverse section of the basilar process of the occipital bone. 2. The anterior round occipito-atlantal ligament. 3. 3. The anterior broad occipito-atlantal ligament. 4. The anterior atlanto-axoid ligament. 5. The commencement of the anterior common vertebral ligament. 6. One of the occipito-atlantal capsular ligaments. 7. One of the atlanto-axoid capsular ligaments. 8. The articulating surfaces of the oblique processes exposed by the removal of the capsular ligament.

† A posterior view of the ligaments connecting the occipital bone to the atlas and the atlas to the axis. 1. A portion of the occipital bone. 2. The posterior arch of the atlas. 3. The axis. 4. The third cervical vertebra. 5. The posterior occipito-atlantal ligament. 6. The opening in the posterior ligament for the vertebral vessels and suboccipital nerve. 7. The posterior atlanto-axoid ligament. 8. The lateral aperture in this ligament. 9. The first pair of ligamenta subflava.

must be removed with the saw immediately behind the oblique processes. The dura mater being next removed from the forepart of the section, we obtain a view of the cuneiform process of the occiput and of the posterior surface of the bodies of the vertebræ covered by ligaments.

Fig. 135.*

The *apparatus ligamentosus*, or middle occipito-axoid ligament, is a thick, flat fasciculus of fibres, which descends from the lower part of the cuneiform process, behind the odontoid process, and is inserted centrally into the superior part of the transverse ligament of the atlas, and below this into the body of the second vertebra, and on either side, very thick, into the bodies of the second, third, and fourth vertebræ. On the latter it becomes continuous with the posterior common vertebral ligament; it is common to the occiput and to the three or four superior cervical vertebræ. The central band is the perpendicular ligament of old writers, and has been described incorrectly as inserted into the point of the odontoid process. This ligament covers the odontoid process and the following ligaments; it serves to attach the head to the cervical vertebræ, and to bind down and secure the lateral ligaments; it also resists too much flexion of the neck.

Fig. 136.†

The *lateral* or *moderator*, or *check ligaments*, arise one from each side of the odontoid process, ascend obliquely outwards, and are inserted into a depression on the inner side of each condyle. These short and strong ligaments are covered posteriorly, or towards the canal, by that last described; anteriorly they are covered by cellular tissue and by the anterior occipito-atlantal ligaments. These have little or no influence over flexion or extension, but they check or regulate the degree of rotatory motion between the axis and the atlas. In rotation of the head, the occiput and the atlas form but one system, which rolls on the pivot-like process of the second vertebra or axis. To the point of the odontoid process there is no true ligament attached; a little filamentous tissue only ascends from it to the anterior edge of the foramen magnum. The two check ligaments are usually united by a fasciculus, which passes above the summit of this process.

* A posterior or internal view of the occipito-axoid articulation, the back part of the occipital bone and vertebral canal having been removed. 1. The basilar process of the occipital bone. 2. The transverse process of the atlas. 3. The axis. 4. The anterior condyloid foramen. 5. The occipito-axoid ligament, or apparatus ligamentosus. 6. Its insertion into the body of the axis. 7. The commencement of the posterior common vertebral ligament. 8. 8. A portion of the lateral or odontoid ligaments. 9. 9. The extremities of the transverse ligament of the atlas.

† A posterior view of the ligaments connecting the atlas, the axis, and the occipital bone. The posterior part of the occipital bone, together with the posterior arch of the atlas and the laminæ of the axis have been removed. 1. The basilar process of the occipital bone. 2. The transverse process of the atlas. 3. The axis. 4. The superior portion of the posterior occipito-axoid ligament, or apparatus ligamentosus; the central portion of which has been removed in order to show the ligaments beneath. 5. The odontoid process of the axis. 6. 6. The lateral or odontoid ligaments. 7. The transverse ligament of the atlas. 8. The inferior extremity of the occipito-axoid ligament. 9. Articulation of the condyle of the occipital bone with the glenoid cavity of the atlas. 10. The articulation of the oblique processes of the atlas and axis.

SECTION V.

ARTICULATION BETWEEN THE FIRST AND SECOND VERTEBRÆ, OR THE ATLAS AND AXIS.

These two vertebræ present three articulations; one in the centre, between the odontoid process and the body of the atlas; and two lateral, between the oblique processes: these may all be considered arthrodial surfaces, the atlas being the recipient for the three, presenting concave, articulating surfaces for each; the central one is vertical and the deepest, the lateral are horizontal and superficial. The central articulation is secured by a transverse ligament and two synovial membranes, and the lateral joints possess the usual capsular and synovial apparatus. These two vertebræ are also connected by an anterior and posterior ligament similar to the occipito-atlantal.

The *transverse ligament* is behind the odontoid process (*see* fig. 136); it describes the fourth of a circle, is thick, broad, and fibro-cartilaginous in the centre; smooth, concave, and polished anteriorly; attached on each side to the inner edge of each oblique process of the atlas, and connected in the centre by a narrow band of the apparatus ligamentosus to the cuneiform process superiorly, and by a broader one to the body of the axis inferiorly, so as to present a cross-like figure so long as these attachments remain. The *synovial membranes* are connected one to the posterior surface of the odontoid process and to the anterior surface of this ligament; the other covers the opposed cartilaginous surfaces of the atlas and of the processus dentatus. By means of this ligament a circular collar is formed, the lower fibres of which form a smaller circle than the superior, which incloses and constricts the base or neck of the axoid process, and binds it to the atlas; while the two synovial sacs are beautiful provisions to admit of the partial rotation of the latter around the former, in which movements the head and atlas may be considered as one solid piece, they not having any independent or separate rotatory motion. The importance of the transverse ligament is great and obvious; hence, when softened and ruptured in disease of this central articulation, death has been instantaneous, the head having fallen forwards, and the odontoid process, projecting backwards, has either compressed or pierced the medulla oblongata.

The lateral articulations are secured by *capsular ligaments* and *synovial membranes*, which are sufficiently lax to admit of the necessary rotatory motions. These ligaments are attached to the circumference of the oblique processes, and are lined by loose and well-moistened synovial membranes, which are thence reflected on the cartilaginous surfaces of the opposed bones: the vertebral vessels are in contact with these capsules; they sometimes communicate with the synovial membranes of the odontoid process.

The *anterior atlanto-axoid ligament* extends from the tubercle and lower margins of the anterior arch of the atlas to the body of the dentatus; is inserted below the base of the odontoid process; is thick and strong, and continuous with the anterior vertebral ligament (fig. 133).

The *posterior* is thin, broad, and weak; extends from the posterior arch of the atlas to the upper edge of the laminæ of the dentatus; it corresponds in situation to the ligamenta subflava inferiorly, but is thin, membraneous, and non-elastic (fig. 133).

SECTION VI.

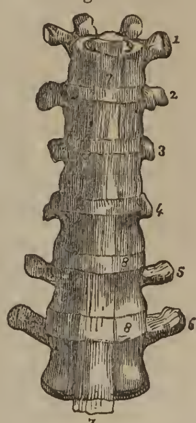
THE COMMON ARTICULATIONS OF THE VERTEBRÆ.

The vertebral column consists of a great number of parts, which are so connected as to combine with considerable elasticity and flexibility sufficient strength to support the whole frame, as well as to afford security to the important nervous organ it contains. From the inferior surface of the second cervical to that of the last lumbar vertebra one similar series of ligaments, though somewhat differently modified in the different regions, serves to unite the several vertebræ to each other, and to connect the whole into one upright and powerful column.

The bodies of the vertebræ are connected by amphiarthrosis, the articular processes by arthrodia, and the other processes by syndesmosis. The ligaments are, therefore, classed into two sets; those which unite the bodies and those which unite the processes. The first comprise the anterior and posterior common vertebral ligaments and the intervertebral fibro-cartilages or ligaments; the second set include the capsules and synovial membranes of the oblique processes, the infraspinous or yellow ligaments, or the ligaments of the laminæ or crura of the spinous processes, the interspinous, the supraspinous, and the intertransverse.

The bodies of the vertebræ are united by an anterior, a posterior, and intervertebral ligaments.

Fig. 137.*



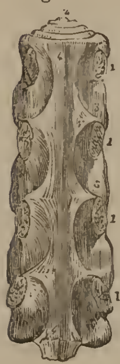
The *anterior vertebral ligament* is a strong band of fibres extending from the axis to the sacrum, and adhering to the bones, particularly to their edges and to the intervertebral substances. Some of the fasciculi are very long, others very short, and some of the deep fibres cross obliquely between the bodies of the vertebræ; its lateral fasciculi are separated from the central by foramina, for the passage of the nutrient vessels of the bones. This ligament is narrow in the cervical and superior lumbar regions, broader, thicker, and more distinct in the dorsal and lower lumbar, but in the neck and loins its edges are confounded with the superincumbent and adjacent tendons. Its relations are obvious; it serves to attach the vertebræ, to strengthen the intervertebral ligaments, and to oppose excessive extension of the column.

The *posterior vertebral ligament* is partly prolonged from the apparatus ligamentosus; extends down the back part of the bodies of the vertebræ, along the front of the spinal canal. It consists of smooth, glistening fibres, of which the superficial are the longest; is narrow in the dorsal and broad in the cervical region; it adheres more closely to the edges of the vertebræ and to the intervertebral ligaments than to the middle of each vertebra, from which it is separated by vessels, principally veins, which escape from the large foramina

* An anterior view of the common articulations of the vertebræ. 1, 2, 3, 4. The transverse processes of the last four dorsal vertebræ. 5, 6. The transverse processes of the first two lumbar vertebræ. 7. 7. The anterior common vertebral ligament. 8. 8. The intervertebral fibro-cartilage.

on the posterior surface of each vertebra; the dura mater can be easily detached from it, being connected to it by delicate cellular tissue. Its margin presents a series of lunated processes, from its being prolonged more laterally on each intervertebral ligament than on the vertebra itself, where it is narrowed. This ligament, like the last, gives strength to the spine; it opposes too much flexion of the column.

Fig. 138.*



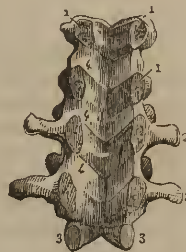
The *intervertebral ligaments*, or *fibro-cartilages*, are placed between the bodies of all the vertebræ, except of the first and second. These substances partake of the fibrous or ligamentous character much more than the cartilaginous; they are united above and below to the flat surfaces of the vertebræ in so intimate a manner that maceration alone can separate them completely, and their own strength and cohesion surpass even that of the bones themselves; they are covered and bound down by the anterior and posterior ligaments. In the neck and loins they are thicker in front than behind, and the contrary in the back; hence in a great degree the peculiar curvatures of the spinal column. Their structure is peculiar and complex; it is best examined in the lumbar region. A horizontal section exhibits an arrangement of tough, fibrous laminæ, apparently concentric, yet not exactly so, for they decussate and intersect each other. These laminæ are more numerous in front and on the sides than behind; towards the surface they are very compact and close, but as they pass more inwards they leave interstices which are filled with a soft, pulpy, whitish, semifluid substance, and towards the centre, or rather a little behind that point, the fibrous tissue becomes rather cellular, the areolæ filled with this viscid pulp. The external layers are the strongest and most elastic, and often present a cartilaginous appearance, and in old persons some portions of these are occasionally found ossified. A vertical section of these substances also exhibits the fibrous structure and the different density of its different portions. In this view the fibres are distinctly seen passing from one bone to another in such oblique courses that they completely decussate. In this section also the ligamentous tissue swells out and expands beyond the limit of the bony surfaces, owing partly to the elastic resistance of the external layers being then removed. When these ligaments are subjected to maceration they swell, become very full and tense, and, if cut horizontally, the central fluid portion will be found to rise up like a conical, pulpy pivot. The intervertebral substance is more perfect in the adult than in the very young or very aged; in the latter the pulpy substance is less, and is yellowish and dry, and the whole ligament is diminished in depth and in elasticity; whereas in the very young the fluid portion is thinner and in greater quantity; it is also of a lighter color, and sometimes presents a rosy tint. At this early age it presents some resemblance to the perfect cup-like cavities filled by fluid between the vertebræ in fish. These ligaments serve to increase the height or length of the spine, without adding much to its weight; to connect most firmly its several component pieces; to complete the spinal canal, also the sockets for the heads of the ribs and the intervertebral foramina; they permit of yielding or flexibility in the column to a great degree, restore the spine to its vertical bearing by their elasticity, which is one of their most remarkable and superior properties;

* A posterior view of the bodies of four dorsal vertebræ, connected together by their ligaments. 1. 1. Sections of the laminæ close to the bodies of the vertebræ, the bony arches and processes having been removed. 2. The conical swelling caused by a horizontal section of the intervertebral fibro-cartilage. 3. 3. The intervertebral fibro-cartilages connecting the bodies of the vertebræ. 4. 4. The posterior common vertebral ligament, presenting a series of lunated processes.

they also lessen the effects of concussion, and prevent shocks being transmitted from the lower limbs to the brain; they constitute the spine a sort of strong, flexible, and elastic spring, in which, while they admit of sufficient yielding in every direction, they at the same time resist too much flexion, extension, lateral, and rotatory motion.

The oblique or articulating processes of the vertebræ are connected by *synovial* membranes and by ligamentous fibres extended irregularly around these, so as to form imperfect capsular ligaments. The synovial membranes are larger and looser in the cervical than in any other region, and smaller and dryer in the dorsal.

Fig. 139.*



The *ligamenta subflava* are situated between the back parts of the plates, or the arches, of the vertebræ; close the intervals between them, and thus complete the back part of the spinal canal. They exist between all the vertebræ from the second to the sacrum; are most distinct in the loins, and are seen best from the interior of the canal. The upper edge of each is attached to the anterior surface of the lamina above, and the lower edge to the upper margin of the lamina below. They are composed of dense, yellow, vertical, and elastic fibres, closely connected together into a plate or lamina, which meets that of the other side in an angle beneath the base of the spinous process: a narrow, vertical, median line separates one from the other. They close the spinal canal posteriorly between the spinous processes, resist flexion of the column, and, by their elasticity, restore it to its erect condition without the expenditure of muscular power. In this respect, as well as in structure, they differ from true ligaments.

The spinous processes of the vertebræ are also connected to each other by ligamentous bands, termed *supraspinous* and *interspinous* (the ligamenta subflava may be called *infraspinous*).

The *supraspinous ligament* extends in the median line from the occipital bone to the sacrum (fig. 140). The cervical portion is usually considered under a distinct title, *ligamentum nuchæ;* attached above to the occipital protuberance, and below to the last cervical spine; and intermediately, by distinct slips, to all the cervical spines, except that of the atlas. These slips separate the muscles on either side. It is connected to and continuous with the numerous tendons of the extensor muscles; very variable in strength and size, and is rudimental of the remarkable structure in the necks of the large quadrupeds, in whom it is composed of the yellow, elastic, fibrous tissue. The remainder of the supraspinous ligament extends from the last, or the prominent cervical spine, to the sacrum; is very thick and strong in the lumbar region and in the interspinous intervals; it is inseparably blended with the extensor tendons. The *interspinous* ligaments are thin, fibrous membranes, placed vertically; attached to the spinous process above and below. They do not exist in the neck, are thin and small in the back, and thick, strong, and square in the loins. The spinal muscles adhere to them on either side (fig. 140).

Between the transverse processes also ligamentous fibres exist, which are named *intertransverse ligaments.* These are thin, fibrous membranes attached to the adjacent muscles; are not distinct in the cervical or superior dorsal region, but are well marked between the lumbar and inferior dorsal vertebræ.

A dislocation of the head from the atlas has been only found in consequence

* An internal or anterior view of the laminæ of the vertebræ connected together by their ligaments. 1. 1. Section of the laminæ which have been sawn through their pedicles, and separated from the bodies of the vertebræ. 2. 2. The transverse processes. 3. 3. The oblique or articulating processes. 4. 4. The ligamenta subflava, or yellow elastic ligaments.

of disease. The first cervical vertebra may be dislocated from the second, either as a consequence of disease or by a violent rotation of the head, or by a fracture of the processus dentatus. Dislocation of one vertebra is extremely rare, and is perhaps never simple, but complicated with violent injury to the bones, ligaments, and muscles.

SECTION VII.

ARTICULATIONS OF THE RIBS.

The true ribs are joined to the vertebræ behind and to the sternum before; the false or the five inferior ribs are only indirectly connected to the latter. Each of the costo-vertebral articulations, with few exceptions, involves two vertebræ and the intermediate substance. The head of each rib presents two slightly convex surfaces, which are received into the depressions on the sides of the bodies of two vertebræ; and the intermediate ridge or angle is connected by ligaments to the intervertebral substance. The tubercle of each rib is also articulated to the concavity on the forepart of the transverse process of the inferior of the two vertebræ, with whose bodies the head of the rib is articulated: thus the posterior end of each rib presents three articulations, two on the head and one on the tubercle; these all belong to the class arthrodia, the vertebræ forming the recipient surfaces. The internal costo-vertebral articulation, or that of the head of the rib, is secured by an anterior or stellate ligament, an interarticular, and two synovial membranes. The tubercle is secured in its socket by a synovial membrane and by an external, a posterior, and an anterior or internal costo-transverse ligament.

Fig. 140.*

First, the *capsular* or *stellate*, or *anterior ligament*, *arises* from the front of the head of the rib, and thence extends over the two synovial membranes in a radiated manner, and is *inserted* by three bands, one into the side of the vertebra above and below, and the third into the intervertebral substance.

The *interarticular ligament arises* from the projecting ridge on the articular surface of the rib; is short, and somewhat yellowish, and is *inserted* into the cavity in the intervertebral substance into which the angle on the head is received; it separates the two synovial membranes.

The *upper synovial membrane* is smaller than the *lower*, and does not communicate with it. The stellate ligament and the synovial membranes are covered by the pleura, the thoracic ganglions of the sympathetic nerve, and on the right side by the vena azygos. The first, eleventh, and twelfth, have only one synovial membrane, and no interarticular ligament, there being only one articulating surface on their heads, which are joined to only one vertebra each.

* A lateral view of the ligaments of the vertebral column and of the articulations of the ribs. with the corresponding vertebræ. The vertebral canal has been laid open inferiorly in order to show the holes of conjugation. 1. A portion of the anterior common vertebral ligament. 2. 2. The intervertebral fibro-cartilage. 3. 3. The supraspinous ligaments.

The tubercle of each rib presents two surfaces, separated by a ridge. The external is rough for the attachment of ligaments; the internal is convex, and covered with cartilage, and is received into the articulating depression at the summit of the transverse process of the inferior of the two vertebræ, to the bodies of which the head is attached. A synovial membrane and three ligaments secure this articulation.

The *synovial membranes* of these external costo-vertebral joints are more loose and distinct than those of the heads of the ribs. The eleventh and twelfth ribs are not articulated to transverse processes, and have only very slight tubercles.

Fig. 141.*

There are three ligaments termed costo-transverse, the posterior, the middle, and the anterior. These secure the connection of the ribs to the transverse processes of the vertebræ; the two first connect the rib to its corresponding vertebra or transverse process, but the last connects this transverse process to the rib beneath; thus these three ligaments arise from the one transverse process; two are attached to the corresponding rib, and the third to the rib beneath.

Posterior or *external costo-transverse ligament,* flat, and somewhat square, *arises* from the posterior surface of the extremity of the transverse process; passes outwards, and is *inserted* into the rough, nonarticular portion of the tubercle of the corresponding rib. This ligament exists on all the ribs, though very loose on the two last.

The *middle costo-transverse ligament* connects the back part of the rib to the front of the corresponding transverse process; it is a short, thick, interosseous ligament, which cannot be seen until a horizontal section of the part be made, or in the act of forcibly tearing the rib from the transverse process.

Anterior or *internal costo-transverse* is wanting in the first and twelfth ribs; *arises* narrow from the lower border of the transverse process, descends obliquely inwards and forwards, and is *inserted* broad into the crest on the upper edge of the rib beneath. The intercostal vessels and nerves lie upon it. Externally it is continuous with the intercostal aponeurosis; internally it bounds the opening through which the posterior branches of the intercostal nerves and vessels pass (fig. 140). From the double mode of articulation of the ribs but little motion can occur, and that only a slight elevation and depression, with a very little rotation. From the length, however, of the ribs, this motion has a considerable effect anteriorly and laterally in enlarging the thorax. All these ligaments are relaxed during inspiration. Simple dislocations of the vertebral ends of the ribs can never occur.

The cartilages of the ribs, at their costal ends, are convex, and are very closely united to the concave surfaces in the extremities of the bones by symphisis, or rather a sort of gomphosis. The sternal ends of the cartilages of

4. 4. The interspinous ligaments. 5. 5. The intervertebral holes, or holes of conjugation. 6. 6. The lateral facettes on the bodies of the vertebræ, for articulation with the head of the rib. 7. A portion of the interarticular ligament of the rib inserted into the intervertebral fibro-cartilage. 8. 8. The articular facette on the transverse process of the vertebra, for articulation with the tubercle of the rib. 9. The anterior surface of the transverse process which gives attachment to the middle costo-transverse ligament. 10. 11. The fifth and sixth ribs. 12. 12. The anterior or stellate ligament of the rib. 13. 13. The anterior or internal costo-transverse ligament.

* A horizontal section of two ribs and a vertebra, to show the middle costo-transverse ligament. 1. The head of the rib, separated from the body of the vertebra. 2. The neck of the rib. 3. The tubercle of the rib. 4. The transverse process of the vertebra. 5. A part of the posterior costo-transverse ligament. 6. The middle costo-transverse ligament.

the seven true ribs, except the first, are convex, adapted to the hollows in the edge of the sternum. These hollows are covered by cartilage and by synovial membranes; each joint is strengthened by ligamentous bands, which proceed from the cartilage before and behind the articulation, and are expanded upon the sternum, and are named *anterior, posterior, superior,* and *inferior sterno-costal ligaments.* There is no distinct joint between the first rib and the sternum; the cartilage and bone appear to be continuous; that of the second is sometimes divided into two cavities. The cartilages of the three superior false ribs are connected to that of the last of the true ribs, and the two last are unconnected. Dislocations of the costal or outer ends of the cartilages of the ribs are very rare; they sometimes, however, occur. Those of the sternal end are still more uncommon.

SECTION VIII.

LIGAMENTS OF THE SUPERIOR EXTREMITIES.

THESE comprise, first, the ligaments which connect the clavicle to the sternum; second, those connecting the clavicle to the scapula; third, those proper to the scapula; fourth, those connecting the humerus to the scapula; fifth, those connecting the bones of the elbow-joint, which will be afterwards subdivided; sixth, those of the wrist-joint, together with those of the inferior radio-ulnar; seventh, those of the metacarpus; eighth, those of the phalanges of the fingers.

SECTION IX.

1. STERNO-CLAVICULAR ARTICULATIONS.

THE articulating end of the clavicle is larger than the surface on the sternum; the former is triangular, the apex behind and below; the latter is rather oblong, slightly convex from before backwards, and concave from within and from above downwards and outwards; it looks outwards, a little backwards, and upwards, and is more on the posterior than the anterior aspect of the bone. The articulating surface on the sternum is extended inferiorly into a smooth depression on the upper surface of the sternal end of the first rib, where it joins its cartilage. This portion is considered by some as a distinct joint (*costo-clavicular*); as, however, its synovial membrane is a part of that which enters into the general articulation, we shall consider the whole as one. The cir-

Fig. 142.*

* An anterior view of the ligaments of the sterno-clavicular and sterno-costal articulations. 1. The anterior surface of the sternum. 2. 2. The clavicle. 3. 3. The first rib. 4. The anterior sterno-clavicular ligament. 5. The costo-clavicular or rhomboid ligament. 6. The interclavicular ligament. 7. The interarticular fibro-cartilage. 8. 9, 10. The anterior sterno-costal ligaments of the first three ribs. 11. 11. The depressions in the edge of the sternum for articulation with the costal cartilages.

cumference of the clavicle is rough for ligamentous attachment. Its articulating surface is inclined downwards and forwards; is uneven, and slightly concave from before backwards, and convex from above downwards. This articulation, which is of the arthrodial species, is secured by an anterior, posterior, inferior, and interclavicular ligament, also by an interarticular cartilage and two synovial membranes.

The *anterior sterno-clavicular ligament arises* narrow from the end of the clavicle, descends inwards, and is *inserted* broad into the forepart of the sternum; is covered by the skin and by the tendon of the sterno-mastoid muscle; it covers and adheres closely to the synovial membranes and to the interarticular cartilage.

The *posterior ligament* takes a course behind the joint parallel to the preceding; it is narrower and weaker than the last, adheres to the joint, and rests upon the sterno-hyoid muscle. These two ligaments are so expanded over the joint as to resemble a capsular or orbicular ligament.

The *inferior*, or the *costo-clavicular* or *rhomboid ligament*, passes from the lower surface of the sternal end of the clavicle downwards, forwards, and inwards, and is *inserted* into the cartilage of the first rib; it closes the angle between it and the clavicle. The tendon of the subclavius muscle is in front of it; its upper or posterior surface is in contact with the subclavian vein. It serves to confine the clavicle in its place, and to resist its dislocation upwards; it also prevents the sterno-mastoid muscle separating the clavicle from the chest.

The *interclavicular ligament* extends from the posterior surface of one clavicle to the other; the deep cervical fascia is attached to its upper concave edge; its lower border is generally attached to the posterior lip of the sternum; it is covered by the integuments, and lies upon the sterno-hyoid muscles. It connects the clavicles to each other and to the sternum; it also protects the soft parts immediately above the latter, and resists the atmospheric pressure at the top of the thorax.

The *interarticular cartilage* is nearly circular; it is thin below, and attached to the sternum and to the cartilage of the first rib; is thick above, and attached to the clavicle; it is very thin, and often perforated in the centre; the sterno-clavicular ligaments adhere to it before and behind; it serves to adapt the two slanting bony surfaces to each other; it also binds them together like a true ligament, at the same time yielding a little to facilitate their motions.

The *synovial membranes* are connected to each surface of this cartilage; they are generally very dry, and the cavity of each is often interrupted by ligamentous bands.

In this articulation the end of the clavicle can move a little upwards, downwards, forwards, and backwards; it also enjoys circumduction. All these motions appear very limited and confined at this joint, but on account of the length of the clavicle they become very considerable at the shoulder. When the sternal end of the clavicle is depressed, the shoulder is raised; when the former is elevated, the latter is depressed; and when the sternal end is directed forwards or backwards, the shoulder is moved in the contrary direction. Of all these motions in this joint, that backwards is the most restricted. Circumduction consists in the combination and succession of these different simple motions, and is more extensive forwards and upwards than downwards and backwards. The shoulder accordingly enjoys it downwards and backwards more freely than forwards or upwards. In these different motions it is easy to perceive the use of the several ligaments, and the manner in which each is affected as to relaxation or tension. The interarticular or fibro-cartilage is of essential service, not merely as a powerful ligament, but, from its close attachment to the clavicle, it yields, and glides a little along with it, and thus prevents its displacement; it also lessens the influence of pressure and concussion from blows or falls upon the shoulder.

SECTION X.

2. SCAPULO-CLAVICULAR ARTICULATION.

The oval end of the clavicle is connected to that of the acromion process in a plain, arthrodial joint, which is secured by a *superior* and *inferior acromio-clavicular ligament.* These are attached to the surfaces of each bone, and, as they are united or continuous before and behind the joint, they may be considered as a strong orbicular ligament. In some individuals, particularly among the laboring class, and on the right side, this capsule, though very thick, is loose and free, and allows the two surfaces to glide freely upon each other, and does not even retain them in apposition, the end of the clavicle being on a much higher level than the acromion. The synovial membrane between these bones is sometimes very imperfect, both it and the fibro-cartilage resembling an intervertebral substance. In other cases there are two distinct synovial membranes, separated by a perfect interarticular cartilage; the latter is thicker at the upper part of the joint, and is often confined to that situation. The deltoid and trapezius muscles strengthen this articulation considerably, and adhere very closely to these ligaments. The two following ligaments do not properly belong to this articulation; they are, however, very essential in connecting the scapula and clavicle; they are about an inch to the inner side of the acromio-clavicular articulation. These are the conoid and trapezoid ligaments.

Fig. 143.*

The *conoid* is the posterior, and the smaller of the two. Its base is attached to a rough, tubercular surface, on the lower and posterior margin of the clavicle; its apex to the base of the coracoid process, in front of the notch in the superior costa of the scapula.

The trapezoid is more anterior and external, it is also broader and stronger, than the conoid; it is about an inch distant from the articulation, and is attached above to an oblique line on the inferior surface of the clavicle; thence it descends obliquely inwards to the upper and internal margin of the coracoid process. These ligaments are united posteriorly and externally; anteriorly they are distinct, the extremity of the subclavian muscle intervening, and sometimes a bursa or synovial sac, which covers a small cartilaginous surface on the coracoid process, and on which the clavicle glides, so as to present a true articulation between these bones.

The *coraco* or *costo-clavicular fascia*, though not a ligament, serves to strengthen the connection between the clavicle and scapula, as also between

* The ligaments of the scapulo-clavicular and humero-scapular articulations. 1. A portion of the clavicle. 2. The upper part of the internal surface of the scapula. 3. The upper part of the humerus. 4. The coracoid process of the scapula. 5. The superior acromio-clavicular ligament. 6. The conoid ligament. 7. The trapezoid ligament. 8. The coraco-acromial or deltoid ligament. 9. The posterior or coracoid ligament. 10. The capsular ligament of the shoulder-joint. 11. The coraco-humeral or accessory ligament. 12. The long tendon of the biceps, passing through the capsular ligament, and descending in the bicipital groove.

both these bones and the first rib. (*See* page 82.) In the acromio and coraco-clavicular articulations the scapula enjoys some motion around the clavicle. At the acromial it glides forwards and backwards, while rotation occurs between the conoid and trapezoid ligaments, the former restraining too much motion forwards, the latter backwards.

The clavicle at its sternal end may be dislocated forwards Displacement upwards or backwards is too rare to merit any notice. In a perfect dislocation forwards the anterior, posterior, costo-clavicular, and interclavicular ligaments, are ruptured; and occasionally the tendinous expansion of the sterno-cleido-mastoid muscle. At its scapular extremity the clavicle may be displaced either above or below the acromion; the latter case is extremely rare, almost unknown. When the clavicle passes above the acromion, the shoulder inclines inwards, being unsupported by this bone, the extremity of which projects beneath the integuments. The superior, inferior, and some fibres of the coraco-clavicular ligaments, are ruptured. The clavicular portion of the trapezius, by elevating the clavicle, assists in this displacement.

SECTION XI.

3. PROPER LIGAMENTS OF THE SCAPULA.—(*Fig.* 143.)

These are two in number, an anterior and posterior.

The *anterior*, or the *deltoid* or *coraco-acromial*, *arises* broad from the coracoid process, passes upwards, and is *inserted* narrow into the point of the acromial process. This broad, thin, triangular ligament is often deficient or weak in the centre; it is covered by the deltoid muscle and the clavicle, and lies over the large bursa which covers the tendon of the supraspinatus muscle; it completes the protecting arch or vault which the acromion and coracoid processes nearly complete over the shoulder-joint.

The *posterior*, or *coracoid ligament*, *arises* from the superior costa of the scapula, behind the notch; passes forwards, and is *inserted* into the base of the coracoid process: it converts the notch into a foramen. This ligament is sometimes wanting; then the notch is completed into a hole by bone. The suprascapular nerve usually passes beneath this ligament, while the vessels of this name run above it.

To these two some add as a third proper ligament of the scapula, the *inferior* or *spino-glenoid*, which, however, is very variable as to strength, and often indistinct. It *arises* from the anterior edge of the root of the spine, passes forwards and outwards, and is *inserted* into the upper part of the cervix. Sir A Cooper conceives that, in fracture of the neck of the scapula, this ligament in some instances serves to suspend the glenoid cavity, and to retain it *in situ*.

SECTION XII.

4. HUMERO-SCAPULAR, OR SHOULDER ARTICULATION.

This joint is an enarthrosis, or ball and socket, though in the dry skeleton it appears to be only an arthrodia. The oval cavity on the scapula is much smaller than the round head of the humerus; both are covered by cartilage, which on the latter is thick on the centre, thin on the circumference, and the contrary on the former.

The head of the humerus is retained in the glenoid cavity by the capsular, the coraco-humeral or accessory, and the glenoid ligaments, and a synovial membrane.

The *glenoid ligament* adheres to the margin of the glenoid cavity, and deepens the socket for the head of the humerus; is strong and fibro-cartilaginous, very thick in its adherent edge, but thin in its free margin, and partly continuous with or derived from the long tendon of the biceps, which passes through the joint like an interarticular ligament, and appears to bifurcate at its upper extremity, and to join this ligament; the tendon itself is separated from the cavity by a fine synovial investment; both surfaces of the glenoid ligament are covered by synovial membrane.

The *capsular ligament arises* around the neck of the scapula (fig. 143). Increasing in size, it encircles the head of the humerus, and is *inserted* into its neck, and prolonged on the periosteum; it is dense above and below, thin internally and externally, very loose and long, but the tendons of the four capsular muscles are identified with it, and to these it is greatly indebted for strength, being almost perfectly covered by them. A small portion, however, inferiorly, and a little internally, that is, between the tendon of the subscapular muscle and that of the long portion of the triceps, is deprived of this support; accordingly, in this situation, although the ligament itself is here rather stronger, dislocations of this joint usually occur. It is covered superiorly by the tendon of the supraspinatus, externally by that of the infraspinatus and teres minor, and internally by the subscapularis. These tendons form a portion of the capsule, and are even partly in contact with the synovial membrane. Inferiorly the long tendon of the triceps adheres to and strengthens it; the deltoid muscle also affords the joint a general support and protection. The apposition of the bones is chiefly owing to the tonic state of the surrounding muscles, as the capsule is too long and large to effect it; hence in paralysis of these muscles the head of the bone falls down. and is partly below the level of the cavity; and in dissection we find, when the muscles have been removed, the bones become considerably separated.

The *coraco-humeral*, or *accessory ligament*, extends obliquely downwards and outwards from the coracoid process to the anterior part of the great tuberosity, where it becomes confounded with the capsule and with the tendon of the supraspinatus muscle.

The *synovial membrane* is reflected over the glenoid surface, around the glenoid ligament; it then lines the fibrous capsule and the tendons of the adjacent muscles, and is next reflected over the head of the humerus; it also lines the bicipital groove by a process of about an inch and a half long, which presents a *cul de sac* inferiorly, and is thence reflected on the tendon, around which it is continued upwards to the summit of the glenoid cavity, so that this cord is not, strictly speaking, within the cavity of the joint. There are often some small, red, fatty masses under this membrane, near the edge of the scapula, and on the neck of the humerus. It frequently presents the appearance of an opening or inflection beneath the coracoid process, above or behind the subscapular tendon; this, however, is merely a communication between the subscapular bursa and the synovial membrane, and the latter is no less a closed sac: a similar communication is also often to be found with the bursa beneath the infraspinatus muscle.

Mr. Flood (Lancet, 1829–30, page 672) has described an *inarticular ligament*, which, he says, "may be easily exposed by cutting through the inferior part of the capsule transversely, and throwing back the arm over the head. You thus expose the interior of the upper part of the capsule, also the biceps tendon. Parallel to the inner edge of the latter this ligament may be felt, and exposed by a little dissection. The tendon of the subsca-

pularis, in passing to its insertions, rests in a notch in the superior and internal part of the edge of the cavity. From the edges of this notch the ligament *arises* broad and flat, then proceeds along the internal edge of the biceps tendon, and becoming smaller and rounder, is *inserted* into a distinct pit in the anatomical neck of the humerus, at the inner edge of the bicipital groove. Its inferior surface is covered by the synovial membrane, and the superior is applied to the fibrous capsule. In its triangular form, its origin at a notch in the articular fossa, and its insertion into a pit, it strongly resembles the 'ligamentum teres' of the hip-joint."

This articulation derives considerable strength and protection from the arch which is formed above it, to nearly the extent of a semicircle, by the coracoid and acromion processes, and by the triangular ligament which unites these. A very large bursa lies beneath this arch and the deltoid muscle, and over the supraspinatus tendon and the superior and anterior regions of the capsule.

The humero-scapular articulation enjoys very free and extensive motion forwards and backwards, analogous to flexion and extension, abduction and adduction, rotation and circumduction. Many of these motions are increased in extent, and at the same time effected with greater facility and safety by the mobility of the scapula on the ribs, and by the yielding and rotation at the acromio and sterno-clavicular joints.

The shoulder-joint, from the great extent of its motions, and form of its articulating surfaces, is more liable to dislocation than any other in the body. This accident may be primary or secondary.

Primary dislocations of the humerus may occur downwards or into the axilla, forwards or under the pectoral muscles, or backwards into the infraspinous fossa. This latter species is extremely rare. A dislocation upwards cannot occur without fracture of the acromion or coracoid process, and therefore cannot be considered among simple dislocations. A primary dislocation, either directly backwards or directly forwards, is not so likely to happen as that downwards, as the strong attachments of the teres minor, supra and infraspinati muscles to the greater tubercle of the humerus, and that of the subscapular to the lesser tubercle, respectively, offer powerful resistance in either of these directions. It is plain, from the construction of this joint, that a dislocation downwards is the most likely to occur; for the lower part of the capsular ligament, being unsupported by muscles, is most weak; and the action of the levator muscles of the shoulder, by rotating the head of the humerus from above down, will bring the head of the bone near to the inferior edge of the glenoid cavity, and thus place it in a situation most favorable for displacement when violence is applied to the extended arm. The greater extent, however, of the glenoid cavity in the vertical direction tends to guard against this accident; also the mobility of the scapula, whereby the glenoid cavity admits of being opposed to the head of the humerus by different muscles; and, above all, by the several muscles and tendons which cover and adhere to the capsule.

When the humerus is dislocated downwards, the head of the bone is found resting on the inferior or sternal costa of the scapula, between the long head of the triceps and subscapularis. The lower portion of the capsular ligament is ruptured, and frequently some of the fibres of the subscapularis. The tendons of the supra and infraspinati muscles, and of the teres minor, are sometimes lacerated, and occasionally the tubercles of the bone are broken. Some of the fibres of the deltoid, pectoralis major, and coraco-brachialis, are also sometimes torn; the long tendon of the biceps usually, but not always, remains unbroken. Independent of external violence, the elevating muscles of the humerus and of the whole arm, (if the elbow-joint be fixed,) with the pectoralis major, latissimus dorsi, and teres major, may, under certain circum-

stances, effect the displacement of the bone. The deltoid and supraspinatus muscles are those which most powerfully resist reduction.

When the head of the humerus is dislocated forwards, it lies on the inner side of the neck of the scapula, between it and the second and third ribs; the serratus magnus and subscapularis generally intervene. The internal portion of the capsular ligament, and sometimes the tendon of the subscapularis, are ruptured.

In dislocation of the humerus backwards, the head of the bone lies in immediate contact with the scapula, under the infraspinatus muscle. The humerus is sometimes partially dislocated in cases of paralysis of the deltoid and of the capsular muscles, or in very aged and debilitated persons.

SECTION XIII.

3. HUMERO-CUBITAL ARTICULATION, OR THE ELBOW-JOINT.

Fig. 144.*

In this, which, as far as the humerus and ulna are concerned, is one of the most perfect ginglymoid articulations, the opposed extremities of the humerus, ulna, and radius, mutually receive each other, and are attached together by an external and internal lateral and by an anterior and posterior ligament. All these ligaments are so closely connected to the surrounding muscles as to be with difficulty separated: there is no distinct capsular ligament, although the aggregate of these might be considered as such.

The *external lateral ligament* is short and flat; *arises* narrow from the external condyle, and is *inserted* broad into the posterior and external part of the annular ligament of the radius. This ligament is confounded with the tendons of the supinator brevis and with those of the extensor muscles.

The *internal lateral arises* narrow from the inner condyle, and is *inserted* in a radiated manner into the inner margin of the great sigmoid cavity of the ulna, between the coronoid and olecranon processes. It is longer and broader than the external, is somewhat triangular, and divides inferiorly into several fasciculi, the anterior of which extend to the coronoid process, and are confounded with the common tendinous origin of the flexor muscles of the forearm; the posterior are inserted into the olecranon process, and are covered by the ulnar nerve, and connected to the adjacent muscles. This ligament adheres to the synovial membrane. The lateral ligaments steady and strengthen this articulation; they also in some measure restrain its motions; the anterior portion of each, particularly of the internal, being tense in extension, the posterior in flexion of the joints. A distinct band of fibres extends from the anterior to the posterior part of the insertion of the internal lateral ligament, or from the coronoid to the olecranon process. In fracture of the latter, the broken piece is often retained in its situation, according to Sir A. Cooper, by this ligament.

* An external view of the elbow-joint. 1. The external condyle of the humerus. 2. The ulna. 3. The radius. 4. The olecranon. 5. The anterior ligament. 6. The external lateral ligament. 7. The annular ligament. 8. The *cul de sac* formed by the synovial membrane of the articulation between the radius and the annular ligament.

Fig. 145.*

The *anterior ligament* consists of thin fibres, which take an irregular direction over the forepart of the joint, some vertically, others obliquely and transversely. They *arise* chiefly from above the internal condyle and the coronoid depression, on the forepart of the humerus. They thence spread over the synovial membrane and some reddish, fatty matter, which is behind the brachiæus anticus. Some are *inserted* into the annular ligament of the radius, others into the coronoid process, and the remainder are lost on the synovial membrane.

The *posterior ligament* is not so distinct as the anterior, unless the forearm be flexed. The fibres chiefly extend in a transverse direction from one condyle and one lateral ligament to the other; they are attached to the synovial membrane, and covered by the triceps and anconæus.

The *synovial membrane* is common to the humero-cubital and cubito-radial articulations. This membrane descends from the forepart of the humerus, behind the anterior ligament and a quantity of reddish, fatty matter which intervenes, to the neck of the radius and annular ligament. Around the former it forms a *cul de sac*, is prolonged into the two sigmoid cavities of the ulna, and thence is reflected to the lateral ligaments and to the triceps tendon, which leads it to the posterior depression on the humerus; it is then expanded over the articular eminences on the lower end of this bone; it is looser before, and still more so behind, than on the sides, and is also thicker in the former situation than in the latter.

The trochlear form of the articular ends of the humerus and ulna constitute this a very perfect hinge-joint, in which flexion and extension can be freely and safely performed. Extension is complete when the arm and forearm are brought into a straight line; the olecranon is then in contact with the humerus, and prevents it being carried further. Flexion can take place to a greater degree, even until the coronoid process strikes the humerus, or until resisted by the intervening soft parts; in flexion the forearm inclines inwards towards the chest and head, in consequence of the oblique direction of the trochlea from behind, and from without forwards and inwards. In these motions the radius may be considered as part of the same system as the ulna, both moving as one bone.

SECTION XIV.

RADIO-ULNAR ARTICULATIONS.

These are two, a superior and an inferior; they are both of the arthrodial class. The shafts of the two bones are also connected by the interosseous ligament. In the *superior* the head of the radius is received into the lesser sigmoid cavity of the ulna, and is retained in it by the following ligament.

* An internal view of the humero-cubital articulation or elbow-joint. 1. The internal condyle of the humerus. 2. The internal surface of the ulna. 3. Its olecranon process. 4. The radius. 5. Its tubercle. 6. The anterior ligament of the elbow-joint. 7. The internal lateral ligament. 8. The annular ligament. 9. The oblique ligament. 10. The interosseous ligament.

Fig. 146.*

The *annular ligament* forms about three-fourths of a circle, the lesser sigmoid depression in the ulna completing it, and is nearly a quarter of an inch deep. It *arises* from the anterior, and is *inserted* into the posterior border of the lesser sigmoid cavity of the ulna. The external lateral ligament of the elbow-joint is inserted into its posterior part, and adds to its thickness in that situation; some fibres of the anterior ligament also are attached to it in front. These attachments serve to retain or suspend it around the head of the radius; accordingly, when they are divided, it falls down round the neck of the radius. Its circumference is wider above than below, whereby it exerts some constricting effect upon this bone. This ligament is lined by the synovial membrane of the joint; it encircles the head and neck of the radius in the same manner as the transverse ligament of the atlas confines the odontoid process of the axis. It often presents a cartilaginous structure.

The *oblique ligament* is a small, round, fibrous cord, weak and variable (fig. 145); *arises* from the root of the coronoid process of the ulna, descends obliquely outwards, and is *inserted* into the inner side of the radius below its tubercle. It is on a plane anterior to the interosseous ligament, and in a contrary direction to its fibres. It separates the flexor digitorum sublimis from the supinator radii brevis muscle; it is made tense in supination.

The most frequent dislocation of the elbow-joint is that of both radius and ulna backwards. This accident is sometimes complicated with a fracture of the coronoid process. The relation of the articulating surfaces in the semiflexed position of the arm is such, that if external violence be applied, the coronoid process slips behind the articular pulley of the humerus, and is lodged in the olecranal fossa, while the humerus is thrown forwards on the radius and ulna. The external, internal, and sometimes the annular ligament of the radius, are ruptured, though the accident may occur without injury to any of these parts. Occasionally even the biceps and brachialis internus suffer from the violent projection of the humerus, and the brachial artery has been known to have been ruptured from the same cause. The flexor muscles of the arm, by keeping it bent, and the triceps by its contraction, are the muscles which oppose reduction. The internal condyle of the humerus and the olecranon present two prominent points, which are of great importance in assisting us to detect injuries about the elbow-joint. In the extended position of the arm they are nearly on the same line, and any displacement of the bones will alter the relation of these two prominences.

The form of the bones, the strength of the lateral ligaments, and the numerous muscles surrounding the joint, prevent a complete lateral luxation of both ulna and radius, while a luxation forwards cannot occur without fracture of the olecranon.

The ulna may be dislocated backwards on the os humeri without being accompanied by the radius. The coronoid process is forced over the pulley of the humerus into the posterior fossa, and the olecranon forms a prominent projection at the back part; the forearm and hand are twisted inwards. The annular and oblique ligaments are ruptured. and sometimes a small portion of the interosseous. The action of the triceps will contribute to keep the bone in this position; while on the contrary, the brachialis internus assists in the reduction.

The radius may be dislocated at its humeral extremity either backwards or

* The superior extremity of the right ulna, with the annular ligament of the superior radio-ulnar articulation. 1. The olecranon process. 2. The great sigmoid cavity. 3. The coronoid process. 4. The annular ligament. 5. The lesser sigmoid cavity.

forwards; when forced through the back part of the capsular ligament, the result of excessive pronation, it is found to rest above the external condyle of the humerus, supported by the brachial fascia. The oblique and annular ligaments are torn, and sometimes the superior fibres of the interosseous ligament.

In dislocation of the radius forwards, which seldom occurs, the head of the bone rests above the external condyle of the os humeri, and resists sudden flexion. The oblique and annular ligaments, with a portion of the interosseous ligament, are ruptured in this luxation, as in the former. The biceps muscle becomes shorter by contraction, and thus may resist, though not in any great degree, reduction.

The opposed edges of the shafts of both radius and ulna are connected by a thin aponeurosis, the *interosseal membrane* or *ligament*. It is composed of long fibres, which descend obliquely inwards from the radius to the ulna, others occasionally cross it in a contrary direction; it is wider in the centre than at either end; is deficient above and below, and in many places is perforated by vessels, inferiorly for the anterior interosseous; the posterior pass through an opening at its upper margin, between it and the oblique ligament. It is not made very tense in any position of the limb; it serves to give attachment to muscles.

In the *inferior radio-ulnar articulation*, contrary to the superior, the round head of the ulna is received into the sigmoid cavity of the radius, and retained in it by a loose *synovial membrane*, or the *sacciform ligament*, which is covered before and behind by some ligamentous fibres, forming an imperfect capsule, and passing from the radius to the ulna. This loose sac is above the interarticular fibro-cartilage, and always contains a large quantity of synovia. It is strengthened by *anterior* and *posterior ligaments*, which are thin and membraneous, and pass transversely from the anterior and posterior margins of the sigmoid cavity of the radius to the front and back of the lower end of the ulna and of its styloid process. These can scarcely be considered as true ligaments, but rather as a part of the sacciform capsule.

The *fibro-cartilage* is triangular. It *arises* narrow from the styloid process of the ulna, and is *inserted* broad into the inner edge of the carpal end of the radius, below the depression for the ulna, which bone it separates from the wrist-joint, and from the cuneiform bone. Its anterior and posterior edges are thick, and connected to the ligamentous fibres that pass from the ulna to the radius; its base and centre are thin, and sometimes perforated: then the wrist-joint and this articulation will communicate. This cartilage appears to be a prolongation of the incrusting cartilage of the lower end of the radius; it serves to unite the radius and ulna very securely, while at the same time it allows the former to roll round the latter, as on a pivot; this cartilage also completes the upper part of the ulnar side of the carpal articulation; it is therefore, both a ligament and an interarticular cartilage. Both the superior and inferior radio-ulnar joints are arthrodial, and the radius enjoys free rotatory motion in each. This rotation is named pronation, when the radius turns over in front of the ulna, and the palm of the hand is directed downwards: the opposite is termed supination. In pronation the head of the radius rolls upon its own axis in the lesser sigmoid cavity of the ulna, its outer border coming forwards, and its inner passing backwards, while the lower end of the radius rolls round the head of the ulna by circumduction, forming an arch of a circle, the centre of which is the ulna, and the arch is the space through which the styloid process of the radius moves. In pronation the latter turns forwards, and in supination backwards; in the former the shaft of the radius crosses in front of that of the ulna, and the interosseous membrane is made somewhat tense; in the latter the two bones become parallel, and the membrane is relaxed.

The carpal extremity of the radius may be dislocated either forwards or backwards. In the first of these accidents this bone is thrown forwards on the scaphoid and os trapezium. The capsular and anterior ligaments alone are ruptured. In the dislocation backwards, the back part of the capsule, the posterior, and sometimes the external lateral ligaments, are ruptured. The bone projects under the skin at the back of the wrist.

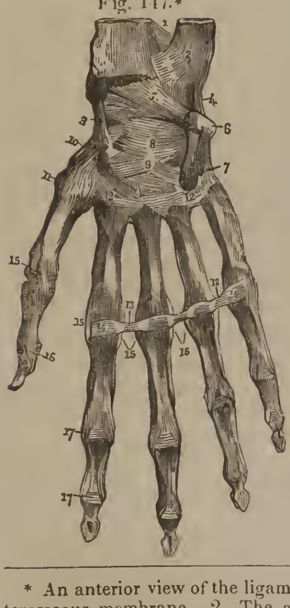
The carpal extremity of the ulna may be dislocated forwards or backwards, the latter is more frequent; the accident is obvious, and the dislocation is easily reduced, but there is much difficulty in keeping the bone in its place in consequence of the rupture of the sacciform ligament.

SECTION XV.

6. RADIO-CARPAL ARTICULATIONS, OR THE WRIST-JOINT.

IN this ginglymoid arthrodial joint, which is of great transverse extent, the lower end of the radius and the interarticular cartilage form a socket for the scaphoid, lunar, and cuneiform bones; the two former are received into the radius, the latter corresponds to the fibro-cartilage, which separates it from the ulna, and excludes this bone from the joint. The wrist-joint is secured by an external and internal lateral, by a posterior and anterior ligament, and by a synovial membrane.

Fig. 147.*



The *external lateral*, or *radio-carpal ligament*, *arises* from the styloid process of the radius, and is *inserted* into the scaphoid bone. Some fibres extend to the annular ligament and to the os trapezium. The radial vessels cross this ligamant.

The *internal lateral*, or *ulna-carpal ligament*, is round and long; *arises* from the styloid process of the ulna, extends obliquely downwards and forwards, and is *inserted* into the cuneiform and pisiform bones.

The *anterior* and *posterior ligaments* descend from the radius and interarticular cartilage anteriorly and posteriorly, and are *inserted* into the superior row of the carpus. The anterior is strong and tense, the posterior is weaker and looser; its fibres, however, are more dis-

* An anterior view of the ligaments of the wrist and hand. 1. The lower part of the interosseous membrane. 2. The anterior inferior radio-ulnar ligament. 3. The external lateral ligament of the wrist-joint. 4. The internal lateral ligament. 5. The anterior ligament of the wrist-joint. 6. The pisiform bone and its ligaments, connecting it to the unciform bone, and to the fifth metacarpal bone. 7. The hook-like process of the unciform bone. 8. The palmar ligaments connecting the first row of carpal bones. 9 The palmar ligaments connecting the second row of bones. 10. The external lateral ligament of the articulation between these two rows of carpal bones. 11. The capsular ligament of the first carpo-metacarpal articulation. 12. 12 The palmar carpo-metacarpal ligaments. 13. 13. The transverse ligaments connecting the heads of the metacarpal bones together. 14. 14. The anterior ligament of the metacarpo-phalangeal articulation. 15. 15. The lateral ligaments of the same articulation. 16. The anterior and external lateral ligament of the phalangeal articulation of the thumb. 17. 17. The anterior lateral ligaments of the index finger; the same are seen upon the other fingers.

tinct; the former is covered by the flexor, the latter by the extensor tendons. These two ligaments, together with the two lateral, may be regarded, and have been described by some, as the capsular ligament.

The *synovial membrane* covers the superior row of the carpal bones, is thence reflected to line the ligaments, and is continued over the articular surface of the radius and of the interarticular cartilage. It is very loose, and contains much synovia. When the bones are pressed together, the membrane may be seen projecting through the ligamentous covering, like small vesicles; it sometimes communicates with the radio-ulnar synovial membrane through the interarticular cartilage.

The *carpal articulation* enjoys four motions, flexion, extension, abduction, and adduction, also a slight degree of circumduction. In *flexion* the upper row of the carpus glides backwards in the cavity, and the hand is directed forwards. In *extension* the former rolls forwards, and the latter is brought into a straight line with the forearm, and can even be carried backwards, so as to form nearly a right angle with the forearm. This might be termed flexion backwards, and is much more extensive than true flexion, in consequence of the articular surfaces of the carpal bones being prolonged further behind than before. In *abduction* the upper end of the carpus moves transversely inwards, and is soon resisted by the styloid process of the radius meeting the scaphoid bone. *Adduction* is less restricted, as the styloid process of the ulna does not descend so low as that of the radius. *Circumduction* is the succession of these several motions, but is rendered less necessary in consequence of the pronation and supination performed by the radius upon the ulna.

The wrist-joint may be dislocated either by the radius and ulna being both thrown forwards, or both backwards. Lateral dislocations seldom occur, and are always partial. These displacements almost always occur by falls on the ground, or other violence, by which the hand is forcibly bent forwards or backwards on the bones of the forearm; extensive laceration of the capsular, anterior, or posterior ligaments, and considerable synovial effusion and swelling, accompany them. The tendons, also, of the flexor and extensor muscles are more or less displaced, and some of them may be ruptured. The form of the arch of the first range of carpal bones favors the dislocation backwards, since, from their greater convexity in this direction, they do not afford as much support to the bones of the forearm.

SECTION XVI.

ARTICULATIONS OF THE BONES OF THE CARPUS.

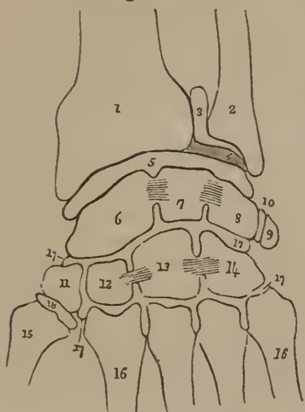
The bones of the carpus are arranged in two rows; three in the superior, in front of which is the pisiform bone; and four in the inferior. Between these rows a certain degree of motion takes place, but between the individual bones in each row there is little or none, except the head of the os magnum and its socket, which is an arthrodial joint; all the others are arthrodial and amphiarthrodial. The proper bones of the first row are the scaphoid, lunar, and cuneiform. These are connected in the following manner:

First. *Interosseous ligaments.*—These are short, compact, and dense tissues, placed between the upper borders of the scaphoid and lunar, and lunar and cuneiform; they range on a level with the carpal convexity of these bones, and are covered by the synovial membrane of the carpus.

Second and third. The *dorsal* and *palmar ligaments* are composed of

strong bands, which pass in different directions from one to another. The palmar are stronger and tighter than the dorsal (fig. 147.)

Fig. 148.*



The pisiform bone, which is the smallest bone of the carpus, does not properly belong to either row; it is articulated to the forepart of the cuneiform only by a flat surface, which is furnished with a loose synovial membrane. Two strong ligaments also connect it, one to the cuneiform bone, and the other to the fifth metacarpal bone. The tendon of the flexor carpi ulnaris and the muscles of the little finger also serve to retain it in its situation, and to attach it to the annular ligament and palmar fascia.

The four bones of the second row of the carpus, like those of the first, are connected together by interosseous substance and by dorsal and palmar bands, which run in every direction. There is no interosseous substance between the trapezium and trapezoid. The second row is articulated to the first by an enarthrosis in the centre and an arthrodia at either side; the central joint is between the round head of the magnum and the cavity of the scaphoid and lunar bones; the lateral arthrodiæ are between the scaphoid and cuneiform bones above, and the trapezium, the trapezoid, and unciform below. These two rows are attached by strong lateral and by anterior and posterior ligaments; the former seem continuations of the lateral ligaments of the wrist, the latter pass from the circumference of one row to that of the other; the aggregate might be considered as a capsular ligament.

The *synovial membrane* between the first and second row is very loose and distinct, and may be considered as common to almost all the joints of the carpus; it lines the inferior surface of the upper row, and sends two processes upwards, one at either side of the lunar bone as high as the interosseous ligaments. From the first row it is reflected on the anterior and posterior ligaments, and thence to the second row, and is very distinct on the magnum, being continued round its neck; it also sends down three prolongations between the four bones of the second row; the most external of these is continuous with the carpo-metacarpal synovial membrane, or that between the second row and the four metacarpal bones: from the latter also there are four prolongations extended between the latter articulating surfaces on the heads of the metacarpal bones. This synovial membrane, therefore, is common to almost all the carpal and metacarpal articulations; there are, how-

* A diagram representing the lower extremities of the radius and ulna. the bones of the carpus, the superior extremities of the metacarpal bones. and the disposition of the synovial membranes which separate them. 1. The lower extremity of the radius. 2. The lower extremity of the ulna. 3. The sacciform membrane. 4. The interarticular fibrocartilage. 5. The synovial membrane of the radio-carpal articulation. or wrist-joint. 6. The scaphoid bone. 7. The lunar bone. 8. The cuneiform. 9. The pisiform. 10. A distinct synovial membrane between the pisiform and cuneiform bones. 11. The trapezium. 12. The trapezoid. 13. The os magnum. 14. The unciform. 15. The superior extremities of the metacarpal bone of the thumb. 16. 16. The superior extremities of the other metacarpal bones. 17. 17. The large synovial membrane which lines nearly all the joints of the carpus; it is separated from the synovial membrane of the wrist joint by the two interosseous ligaments connecting the scaphoid. lunar, and cuneiform bones. 18. A distinct synovial membrane between the trapezium and metacarpal bone of the thumb. Five separate synovial membranes are thus exhibited in the above diagram, and numbered 3, 5, 10, 17, and 18.

ever, some excepted; thus between the pisiform and unciform there is a distinct synovial membrane, another also between the trapezium and the metacarpal bone of the thumb, and sometimes also a distinct one between the third and fourth metacarpal bones. The continuity of this one synovial membrane through so many articulations, and its contiguity to the other membranes in this region, are well exemplified in cases of synovial inflammation or disease of the carpus.

The bones of the carpus are also firmly connected to each other by the *annular ligament,* which is a strong and compound fibrous structure; *inserted* externally into the trapezium and scaphoid, and internally into the cuneiform, unciform, and base of the pisiform bones; it preserves the arched form of the carpus, and completes the ring for the passage of the flexor tendons, median nerve, and carpal bursa.

Although the carpus consists of so many joints, yet it enjoys but little motion in any of these, and the principal use of this complex structure is to effect security or strength, to allow of slight yielding, and, above all, to lessen the effects of concussion, which is broken or scattered by so many articulations. There is no appreciable motion between the individual bones in each row, but the lower row can move beneath the upper in consequence of the enarthrosis of the magnum and the arthrodiæ on either side of it. This motion is either forwards or backwards; the former or flexion is more obvious than the latter.

The close connection of the bones of the carpus, and the numerous ligaments spread in all directions over the back and front of the hand, present powerful obstacles to complete dislocations of any of these bones. The only one at all likely to occur is that of the head of the os magnum backwards from the depression in the semilunar and scaphoid bones. Here the quantity of motion is greatest, and the joint is very weak and loose in some feeble persons; however, this luxation is generally incomplete.

SECTION XVII.

THE ARTICULATIONS BETWEEN THE CARPUS AND METACARPUS.

The five metacarpal bones present two series of articulations, the posterior or carpo-metacarpal, and the anterior or metacarpo-phalangeal. In the carpo-metacarpal series the carpel ends of the four internal metacarpal are joined to the lower row of the carpus, by nearly plane surfaces, and are secured before and behind by transverse and oblique fibrous bands, which cover the synovial membranes, and pass in different directions, and are named *dorsal, palmar,* and *interosseous.* The synovial membrane, between the trapezium and the metacarpal bone of the thumb, is distinct from the rest, and this joint possesses a *capsular ligament,* the pulley-like surfaces of the bones admitting of very free motion, adduction, abduction, flexion, extension, and slight rotation. The other carpo-metacarpal joints are also furnished with synovial membranes, which are prolonged from that between the first and the second row of the carpus, except in the case of the third and fourth, which sometimes possess a distinct sac. The second metacarpal bone is articulated to the trapezium, trapezoid, magnum, and to the third metacarpal bone; the third to the magnum and to the second and fourth metacarpal bones; the fourth to the magnum, unciform, and to the third and fifth metacarpal bones; the fifth to the unciform and to the fourth metacarpal bone. In these articulations there is very little motion beyond a mere yielding be-

tween the surfaces, except in that between the trapezium and first metacarpal bone, where free and varied motion is permitted. Between the fifth and the unciform bone, also, considerable motion can occur, flexion, extension, abduction, and adduction, but no rotation. The anterior or digital extremities of the metacarpal bones are not in contact, but are connected together by a strong transverse band of ligamentous fibres.

The dislocations of the metacarpal bones from the carpus seldom occur, except in the case of the first metacarpal bone, which may be dislocated from its articulation with the trapezium forwards or backwards. In the backward luxation the carpal extremity of the bone is driven through the posterior part of the capsular ligament. The lateral ligaments may or may not be ruptured. The flexor ossis metacarpi and flexor brevis and longus, with the adductor, offer great resistance to reduction when delayed for any time. In the dislocation forwards the metacarpal bone is thrown between the trapezium and the root of the second metacarpal bone; the thumb is bent back, and cannot be flexed: the external lateral ligament is in this case more likely to be torn than in the former. The extensors of the thumb are the muscles which offer resistance to reduction of this dislocation.

SECTION XVIII.

ARTICULATIONS BETWEEN THE METACARPUS AND THE PHALANGES.

These arthrodial joints are furnished with capsular ligaments and synovial membranes. The sockets do not receive the entire head of each bone, the latter being much larger, particularly on their posterior aspect. The *capsules* are weak and lax behind, strong on the sides, like distinct lateral ligaments, and very close and compact in front, often with somewhat of a cartilaginous structure. In the thumb this ligament lodges the sesamoid tubercles; in this finger also this articulation differs from that in the other fingers, in possessing but little motion in any direction except that of flexion and extension, whereas the others possess also the power of adduction, abduction, and slight rotation. These articulations are much strengthened by the tendons of the flexors, extensors, lumbricales, and interosseal muscles; the four internal are also secured by strong *transverse* ligaments passing from one to the other.

The first phalanx of the thumb is the only joint of this series very liable to dislocation; it is frequently dislocated backwards from the head of the metacarpal bone. The lateral ligaments remain uninjured, and become very tense. This dislocation is interesting from the great difficulty of reducing it when neglected even for a short time. The phalanges of the other fingers may be dislocated either backwards or forwards; these accidents are obvious, and, when recent, easily admit of reduction.

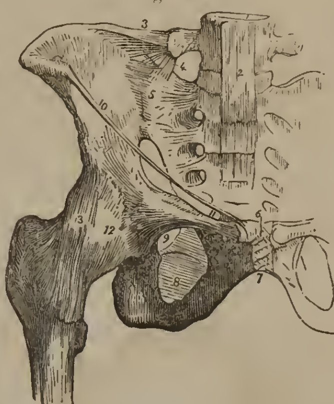
The ginglymoid articulations of the phalanges are secured by *synovial membranes* and by very strong *lateral* and *anterior ligaments*. Posteriorly the synovial membranes are only partially covered by the extensor tendons; but anteriorly they are perfectly protected by the flexor tendons and their sheaths.

SECTION XIX.

ARTICULATION BETWEEN THE PELVIS AND THE SPINE—LIGAMENTS OF THE PELVIS.

The last lumbar vertebra is joined to the sacrum in the same manner as the other vertebræ are joined to each other by an intervertebral, anterior and posterior, yellow, supra and interspinous, synovial membranes, and capsular ligaments. The intervertebral ligament is remarkably thick, particularly in front. This connection is also strengthened by the *lumbo-sacral ligament*, a strong, short, thick, fibrous band, extending from the transverse process of the last lumbar vertebra to the posterior part of the base of the sacrum, where it is continuous with the ligaments of the sacro-iliac synchondrosis.

Fig. 149.*



The two last lumbar vertebræ are connected to the ilium by the *ilio-lumbar ligament*. This is of a triangular form, and sometimes divided into two; it *arises* from the transverse processes of the fifth and fourth lumbar vertebræ and from the back part of the sacrum, proceeds horizontally outwards, and is *inserted* into the posterior superior spine of the ilium and into the crest of this bone, in front of that process.

The several bones of the pelvis are connected together by syndesmosis and synchondrosis; they present no perfect or true joints, but belong to the class of amphiarthrosis. The pelvic articulations are the sacro-coccygeal, sacro-iliac, sacro-sciatic, and pubic.

The sacrum and coccyx are joined by a thin *anterior* and a thick *posterior sacro-coccygean ligament;* also by a thin, intervertebral *fibro-cartilage*, which latter is very variable. It is usually more perfect, and allows of more motion backwards and forwards, in the female than in the male; occasionally in the former there is a small synovial sac between the bones.

The sacro-iliac articulation, or synchondrosis, is secured by anterior and posterior ligaments. The *anterior sacro-iliac ligament* is thin, and consists of fibres passing transversely from one bone to the other. The *posterior sacro-iliac ligament* consists of several thick fasciculi passing transversely and obliquely from the rough surface of the sacrum to that of the ilium and to its posterior superior spine. The *sacro-iliac synchondrosis*, or *symphysis*, connects the auricular surfaces of these bones. Each is covered in this anterior portion by a lamina of closely adhering cartilage, thicker on the sacrum than

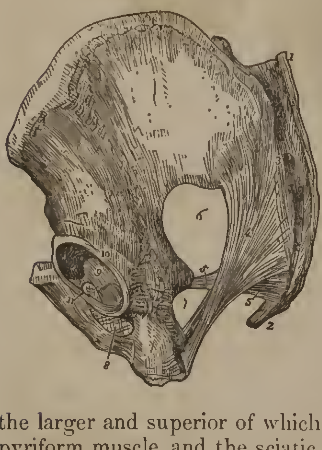
* An anterior view of the ligaments of the pelvis and of the hip-joint. 1. The last lumbar vertebra. 2. The lower part of the anterior common vertebral ligament, extending downwards over the front of the sacrum. 3. The ilio-lumbar ligament. 4. The lumbo-sacral or sacro-vertebral ligament. 5. The anterior sacro-iliac ligaments. 6. The anterior pubic ligament. 7. The inferior pubic or sub-pubic ligament. 8. The obturator ligament or membrane. 9. The opening in the obturator ligament for the passage of the obturator vessels and nerve. 10. Poupart's ligament. 11. Gimbernaut's ligament. 12. The capsular ligament of the hip-joint. 13. The ilio-femoral or accessory ligament.

on the ilium. These surfaces are irregular, and sometimes present a lubricated surface, as if furnished with an imperfect synovial membrane. In the child this connection is looser, also in the pregnant female; and in both cases a synovial membrane is more distinctly developed, containing a little reddish fluid. In the adult male a soft, yellowish matter is sometimes found to intervene, and the surfaces are very uneven, and appear indented into one another. In the aged these bones are sometimes anchylosed. Behind the auricular surface the two bones are strongly attached together by a mass of interosseous fibres.

The sacrum and ischium, though not in contact, are connected together on either side by the two following very strong and important ligaments.

The *posterior* or *great sacro-sciatic ligament* arises broad from the lower and back part of the posterior inferior spine of the ilium and from the back part of the sacrum and coccyx; descends obliquely outwards, becomes narrow and thick, and is *inserted* again broad into the lower and inner edge of the tuber ischii, and by a falciform process continued forwards into the ramus of the ischium, to which the obturator fascia is attached, and which serves to conduct, support, and protect the internal pudic vessels and nerves. It is covered posteriorly by the glutæus maximus, some fibres of which arise from it; it is perforated by small vessels, and rests upon the anterior sacro-sciatic ligament. By its upper border it converts the lesser sciatic notch into a foramen, and by its lower it completes the posterior and lateral boundary of the lower or perinæal opening of the pelvis on each side.

Fig. 150.*



The *anterior* or *lesser sacro-sciatic ligament* crosses in front of the former; is triangular, and very thin; *arises* broad from the side of the sacrum and coccyx, passes outwards, and is *inserted* narrow into the spine of the ischium. Its origin is intermingled with the fibres of the former, which are behind it; its anterior or pelvic surface is covered by the coccygeus muscle; it separates the two sciatic foramina. These four ligaments are situated at the lower and back part of the pelvis; they serve to attach the sacrum and ossa coccygis to the ossa innominata; they also assist in forming the parietes of the pelvis, and by their decussation they constitute the two openings on each side known by the names of the greater and lesser sacro-sciatic notches, the larger and superior of which transmits the glutæal nerves and vessels, the pyriform muscle, and the sciatic and pudic nerves and vessels; the inferior or lesser transmits the internal obturator tendon and the internal pudic vessels and nerves.

Pubic symphysis connects the vertically oval surfaces of the ossa pubis, which are covered by cartilage and by a fibro-cartilage analogous to the intervertebral. It consists of several concentric laminæ; some of these are oblique, and intersect others; some are continued all round; others are deficient

* A lateral view of the ligaments of the pelvis and hip-joint. 1. The lower part of the supraspinous ligament of the vertebræ descending over the median tubercles on the back of the sacrum. 2 The posterior sacro-coccygean ligament. 3. The sacro-spinous or oblique sacro-iliac ligament. 4. The posterior or great sacro-sciatic ligament. 5. The anterior or lesser sacro-sciatic ligament. 6. The great sacro-sciatic foramen. 7. The lesser sacro-sciatic foramen. 8. The obturator ligament. 9. The cotyloid cavity or acetabulum. 10. The cotyloid ligament. 11. The transverse ligament which converts the inferior notch of the acetabulum into a foramen.

behind; and they are all thicker above and before than below and behind. In the centre there is often a pulp, or a viscid fluid; and sometimes a small and imperfect synovial membrane and cavity intervenes between the bones posteriorly. The symphysis is covered in front by a thick, laminated, and fibrous tissue (anterior pubic ligament), the fasciculi of which run in different and decussating courses. Superiorly and posteriorly, in like manner, it is strengthened by ligamentous fasciculi (*superior* and *posterior pubic ligaments*). The posterior is thin, and often rendered very convex towards the pelvis by the prominence of the edges of the bones in that direction. Beneath the symphysis is the *subpubic ligament*, which consists of a compact and thick band of semilunar fibres passing from one ramus to the other; connected superiorly to the symphysis; inferiorly it rounds off the angle or arch of the pubes. The interosseous membrane, or the triangular ligament of the urethra, is inferior to this, and on a plane anterior to it.

The *obturator ligament* is a thin fibrous membrane, but not a true ligament, adhering to the margin of the obturator hole, except superiorly, where it is deficient, to allow the obturator nerve and vessels to pass out obliquely.

SECTION XX.

ILIO-FEMORAL ARTICULATION, OR HIP-JOINT.

This is the strongest and most perfect enarthrosis in the system; it includes the head of the femur and the acetabulum, both of which are incrusted with cartilage, and is secured by a capsular and an accessory ligament, a synovial membrane, an interarticular, cotyloid, and a transverse ligament. The cartilage on the head of the femur is thickest on its most convex portion, but is deficient a little below its centre, where there is a depression for the insertion of the interarticular ligament. On the surface of the acetabulum it is thicker towards the circumference, and is altogether absent in a considerable space extending from the notch to the centre. The former lodges the origin of the interarticular ligament, the latter a mass of articular fat and several blood-vessels.

Fig. 151.*

The *ilio-femoral capsular ligament* (fig. 149) is the strongest in the body; is analogous to that of the shoulder-joint, but not so loose, neither are the surrounding tendons so identified with it. There is a large bursa on its anterior surface, between it and the tendon of the psoas; in some rare cases this communicates with the cavity of the joint. Another bursa is placed more externally between the great trochanter and the glutæs maximus: there are also several others connected to the surrounding tendons. It *arises* from the os innominatum by a very strong attachment, which extends from half an inch to an inch and a half beyond the brim of the cavity: anteriorly from the inferior spine of the ilium, from

* Ilio-femoral articulation. In this view a vertical section has been carried through the hip-joint, and the head of the femur drawn out of the acetabulum, in order to show the relation of the various structures of the articulation. 1. A vertical section of the os ilium, passing through the cotyloid cavity or acetabulum. 2. A vertical section passing through the head, neck, and great trochanter of the femur. 3. A section of the acetabulum and its cartilage of incrustation. 4. A section of the cotyloid ligament. 5. The capsular ligament. 6. A section of the cartilage of incrustation on the head of the femur. 7. The insertion of the interarticular ligament, or ligamentum teres, into the head of the femur. 8. The ligamentum teres. 9. The cavity of the synovial membrane.

the body of this bone, and from the ilio-pubal eminence; superiorly or externally from the ilium, extending to some distance above the prominent border of the acetabulum; posteriorly as far upwards as to a line leading from the outer part of the ilium to the spine of the ischium; inferiorly from the ischium, external to its tuberosity; internally from the outer border of the thyroid foramen, and from the cotyloid and transverse ligament of the notch. The fibres form a dense and compact tissue, strong, tough, inelastic, and unyielding. The superficial fibres have mostly an obliquely vertical course, but the deeper interlace in every direction. The capsule passes downwards and outwards, incloses the cotyloid ligament, but does not adhere to it except at the notch; enlarges opposite the head of the femur, then becomes flattened and contracted to embrace the cervix, the greater part but not the whole of which it incloses. It is *inserted* superiorly and externally into the root of the neck, internal to the digital fossa of the great trochanter; anteriorly into the anterior intertrochanteric ridge and into the forepart of the neck above this line; internally and inferiorly it descends near to the root of the lesser trochanter, and is inserted into the rough surface above it; posteriorly it does not descend so low as in front, and is inserted into the neck about a quarter of an inch above the posterior intertrochanteric ridge. These insertions are partly into the bone, and are partly prolonged into the periosteum both inferiorly and superiorly. In the latter direction several distinct fibrous cords are observable, on the anterior and inferior surface particularly, passing upwards in the periosteum, beneath the synovial membrane. These cords are variable, and in some instances are very much developed; they have been named *retinacula*. The capsule extends further down in front than behind, and is stronger above and before than in other situations; it is tense on all sides, except internally and inferiorly, where it is rather loose, and thereby admits of the more easy abduction of the thigh. It presents very different degrees of strength and thickness in different parts, these properties being imparted to it where the greatest force and pressure are to be applied, and where great resistance is required; thus it is very thick above, also in the outer part of its anterior portion, and is thinner posteriorly and internally. At the lower and internal part it is so thin in children, and the fibres so scattered, that the synovial membrane can be seen through it. It derives considerable increase in strength from the adjacent tendons, and from accessory bands, particularly the following.

Accessory or *ilio-femoral* ligament (fig. 149) is a strong and thick fibrous band, incorporated with the capsular, *arising* from and around the inferior spinous process of the ilium; it descends obliquely inwards, becomes broader, and is *inserted* into the anterior intertrochanteric line, near to the lesser trochanter; it strengthens the capsule anteriorly, and opposes the head of the femur in extension of the thigh. From the pubis also a smaller accessory band descends on the inner side of the capsule, as far as the root of the lesser trochanter; between these bands, and immediately behind the psoas and iliac muscles, the forepart of the capsule is thin, and occasionally presents a round foramen, which leads into the bursa, placed between it and these tendons. The capsule and the articulation generally derive most important additional security from the surrounding muscles and tendons; anteriorly from the psoas and iliac, externally and superiorly from the rectus, particularly its long outer head, which, arising from the dorsum of the acetabulum, bends around its upper to its forepart; externally or superiorly the glutæus minimus, also, adheres closely to the capsule; posteriorly the quadratus femoris, pyriformis, gemini and obturator internus, and internally the obturator externus and pectinæus.

The *synovial membrane* is exposed by dividing the capsular ligament, whose internal surface it lines to a great extent; it is continued from the head of the

femur around the neck near to its base, but not so far as the fibrous capsule; on the neck it is loose in some parts, and thrown into little folds or wrinkles which adhere to strong fibrous bands, the thickened portions of periosteum or retinacula before noticed, which extend from the head along the neck. From the latter the synovial membrane is reflected to the capsule, along which it is conducted to the outer circumference of the acetabulum: it then covers both surfaces of the cotyloid ligament, lines the acetabulum, covers and adheres to the fatty mass at the bottom of this cavity, and is then reflected along the interarticular ligament to the head of the femur.

The *articular fatty mass* has a peculiar reddish and often a dark appearance; it fills the rough surface in the acetabulum, and is confined in its place by the synovial membrane and by a number of decussating tendinous bands. It receives a great number of bloodvessels and nerves, chiefly from the obturator, through the notch; these are also small, red, fatty masses around the neck of the femur, and one at the insertion of the interarticular ligament in the head of the bone.

The *cotyloid ligament* (fig. 150) is the fibro-cartilaginous lip which deepens the acetabulum, and at the same time narrows its orifice, so as to hold the head of the femur, even after the capsular ligament and all the muscles have been divided; and it fits so tightly around it, that the head appears to be retained in the socket partly by atmospheric pressure. It is composed of strong circular fibres; these pass deep into the notches in the border of the acetabulum, and thereby level off all irregularities; its attached border is very thick, in some places nearly a quarter of an inch; its free margin, which inclines inwards or centrally, is thin and sharp; a vertical section of it, therefore, presents a triangle, the base upon the bone; it is covered on each surface by the synovial membrane; it is very thick and deep superiorly and posteriorly; its fibres adhere intimately to the bony margin, but are not continuous with the incrusting cartilage of the cavity; a distinct fissured line divides them. It adheres intimately to each cornu of the cotyloid notch, and is distinct from the ligament of the latter. It serves to deepen the acetabulum, and to level the irregularities in its margin, also to prevent the neck of the femur striking against the latter.

Transverse ligament consists of ligamentous bands, which pass across the notch in the border of the acetabulum; some pass from the pubis to the ischium, others decussate these and pass from the ischium to the pubis. It completes the margin of the cavity, and leaves sufficient space above and behind it for the passage of vessels and nerves to the cotyloid fat.

Interarticular ligament, or *ligamentum teres*, is about an inch and a half in length; it consists of fine ligamentous fibres covered rather loosely by synovial membrane. Though called round, it is rather of a triangular yet tapering form, the base attached to the notch, and by the synovial membrane, to the depression in the acetabulum; the apex to the head of the femur. It *arises* by two flat bands, the superior of which is the smaller; from the margins of the cotyloid notch, these soon unite and are enveloped by the synovial membrane; it then runs upwards, backwards, and outwards, contracting in size, between the articular fatty mass and the head of the bone, into the depression on which it is *inserted*. This ligament is very variable as to size and strength; is rarely wanting in man, but is absent in some animals; it serves to conduct bloodvessels from the acetabulum to the head and neck of the femur, which, from its position in respect to the shaft of the bone, may require a nutritious supply from this source: some consider it may also limit too much abduction of the thigh.

This joint enjoys free motion in every direction: flexion. extension, abduction, adduction, rotation, and circumduction. In *flexion* the head and neck move round the same imaginary axis, the anterior portion of the capsule is

relaxed, and the posterior is made tense, in proportion as the flexion increases. In *extension* the head of the femur projects against the forepart of the capsule, and is supported by the accessory ligament and by the psoas and iliac tendon; too much extension is prevented by the neck of the femur meeting the posterior border of the acetabulum. In *abduction* the head of the bone presses the lower and inner part of the capsule, which is rather loose and yielding, and the limb can be separated from the median line to a considerable extent. In *adduction* the head of the bone moves a little outwards into the deepest part of the cavity, and the thighs are approximated; if the thigh be a little flexed, this motion can be increased so as to cross the limbs. In *circumduction* there is a succession and combination of the preceding simple motions, and the limb describes a cone, the apex of which is in the articular cavity. In *rotation* the great trochanter moves in an arch of a circle, forwards in rotation inwards, backwards in rotation outwards; the centre of this circle is in the joint, and its radius is the axis of the head and neck: rotation outwards is more free and extensive, on account of the aspect of the head and the direction of the neck, and the number of muscles which contribute to it; it is also the natural state of the limb, so that even at rest the toes are directed outwards.

The depth of the acetabulum, the strength of its capsular ligament, together with the surrounding muscles, all seem well adapted to prevent luxation: such accidents, however, not unfrequently occur. This joint is not so liable to dislocation as that of the shoulder, for several reasons: in the first place, its motions are much more limited in extent; second, the glenoid cavity affords little mechanical security, while the cotyloid, on the contrary, permits the head of the femur to sink into it; third, the oblique direction of the head of the thigh-bone presents an additional obstacle: fourth, the capsular ligament of this joint is much stronger and shorter than that of the shoulder, and it is further protected by very strong accessory fibres and by several muscles.

This joint may be dislocated in four directions; backwards and upwards on the dorsum of the ilium; backwards on the ischiatic notch; forwards and upwards on the pubis; and forwards and downwards, or inwards, on the foramen obturatorium.

The situation of the trochanter major is a point of great importance in discriminating accidents about the hip-joint, and its relation to some other prominent points should be kept in mind; in the erect position of the body, the superior part of the trochanter is nearly on a level with the crest of the pubis; the distance between the anterior superior spine of the ilium and the trochanter major is less than from this projection to the os pubis, or from the os pubis to the anterior superior spine. Lines connecting these three points will form nearly a right-angled triangle, of which the longest side is the line connecting the superior spine to the pubis, and the shortest, that which joins the spine to the trochanter. In dislocation upwards or backwards the trochanter is brought nearer the superior anterior spine of the ilium, but is much less prominent than natural; in the luxation backwards it is removed from the body of the pubis, and is also less prominent than natural; in the dislocation into the obturator foramen, the distance between the trochanter major and the body of the pubis is lessened, while that between this process and the anterior superior spine is greater than usual.

In dislocation *upwards* and *backwards*, which is the most frequent, the head of the bone rests on the dorsum of the ilium, the upper part of the capsular ligament is ruptured, and the accessory and round ligaments are torn: the limb is shortened about two inches, and is inverted and more or less fixed. In rotation inwards the head of the femur is pressed against the back part of the capsular ligament, and if the rotation be carried far, a considerable portion of the bone is outside the cotyloid cavity; hence the species of disloca-

tion now described is most likely to occur when rotation inwards is accompanied by external violence, that is, by the individual falling or receiving a blow when the knee and foot are turned inwards. When this dislocation has occurred the three glutæi muscles are those principally concerned in keeping the head of the bone fixed on the dorsum of the ilium; but when the limb has been extended and the head of the bone is sufficiently raised to pass over the edge of the acetabulum, the psoas and iliacus, with the obturator externus and pectinalis, will assist to bring it into the proper situation. Although in common cases of dislocation we may presume, from the rapid recovery of the patient, that no other injury is done to the joint than what has been already described, yet the dissection of a case of luxation upwards and backwards has been published, in which the gemini, pyriformis, obturators, and quadratus femoris, were completely torn across: there was also laceration of some fibres of the pectinalis.

In the dislocation backwards, and which is also a little upwards, or that into the ischiatic notch, the head of the bone rests on the pyriformis muscle, and between it and the sciatic ligaments, the limb is a little shortened, it is also inverted, but much less so than in the dislocation on the dorsum of the ilium. This dislocation, also, is most likely to happen, the force being applied when the thigh is rotated inwards and flexed.

When the femur is dislocated forwards on the obturator foramen, the capsular ligament and the internal accessory fibres are lacerated; the ligamentum teres is, according to Sir A. Cooper, always ruptured; the limb is lengthened from one to two inches; the knee is advanced and abducted with slight eversion; the great trochanter is much less prominent than usual.

In dislocation upwards and forwards the head of the bone rests on the ramus of the pubis, under Poupart's ligament, where it may be plainly felt; the limb is shortened, slightly flexed, and everted.

A calculation has been made, that out of twenty dislocations of the hip-joint, twelve take place on the dorsum ilii, five on the ischiatic notch, two on the foramen ovale, and one on the pubis.

SECTION XXI.

FEMORO-TIBIAL ARTICULATION OF THE KNEE-JOINT.

The condyles of the femur, the head of the tibia, and the patella, enter into this arthrodial ginglymoid articulation; the fibula is only remotely connected with it. The ligaments which secure it may be classed into those external and those internal to the synovial membrane, although strictly they are all external to it. The *external ligaments* are the ligamentum patellæ, ligamentum posticum, and the internal and external lateral ligaments. The *internal* are the two crucial, the two interarticular fibro-cartilages, the transverse, and certain folds of the synovial membrane.

Several bursæ are in its vicinity; three are placed on its anterior aspect; these may be named the superior, middle, and inferior. The first and last are deep-seated; the second is *subcutaneous* on the patella, and partially covered by an imperfect fascia; its cavity is frequently intersected by tendinous bands. The *superior bursa* is on the forepart of the femur, behind the extensor tendons, and surrounded by fat; it is very thin, and in some cases only a distinct sac; it usually communicates with the cavity of the joint so freely as to appear as a *cul de sac* of the synovial membrane itself, a mere circular constriction marking the separation. To this bursa, or to the synovial membrane,

some muscular fibres are attached (page 308). The *inferior bursa* is small and delicate; is situated between the tubercle of the tibia and the ligament of the patella. There are various other small bursæ connected to the adjacent tendons. Although there is no regular capsular ligament to this joint, yet its place is in a great degree supplied by the fascia lata and by the aponeuroses from the vasti and the other lateral muscles and tendons, which give it a very perfect covering. On the outer side of the joint the fascia lata is very strong and tense, extending as a broad ligament from the vastus externus and from the outer condyle of the femur, to the anterior border of the tibia. and to the aponeurosis of the leg. On the posterior aspect is the aponeurotic expansion from the semi-membranosus tendon. In the centre, and at either side, the femoral condyles are covered by a strong fibrous tissue, which is supported by the constant pressure and action of the heads of the gastrocnemii; the latter also are sometimes strengthened by sesamoid tubercles. The bony surfaces which compose this joint have been already described. These are covered in the usual way with a compact cartilage. On the femur this extends much higher on the condyles in front than behind, and does not at all cover the sides; on the tibia it is thicker in the centre than at the circumference, contrary to the general condition in arthrodial surfaces. This apparent anomaly, however, is removed by attending to the position of the semilunar cartilages, which deepen the border of these cavities so considerably.

Fig. 152.*

Fig. 153.†

The *ligamentum patellæ* consists of strong, parallel, glistening, tendinous fibres, which *arise* broad from the inferior angle and from the anterior surface of the patella, descend obliquely outwards and backwards, and are *inserted* narrow into the tubercle of the tibia, a little below the small bursa which lies behind this ligament. This ligament is principally a continuation of the extensor tendon, in which the patella was developed at first in the form of cartilage, in the same manner as the sesamoid bones are; it is about two inches long, and narrower in the centre than at either end; is covered by the skin and fascia lata, and bound down by the latter so as to be concave towards the surface; it lies upon a quantity of soft adeps and upon the small inferior bursa.

The *posterior ligament* has been noticed in the dissection of the semi-membranosus muscle, from the tendon of which this quad-

* An anterior view of the ligaments of the femoro-tibial articulation or knee-joint. 1. A portion of the tendon of the quadriceps extensor muscle of the leg. 2. The patella. 3. The ligamentum patellæ. 4 The tibia. 5. 5. The synovial membrane. 6. A part of the internal lateral ligament. 7. The long external lateral ligament. 8. The anterior superior tibio-fibular ligament. 9. The fibula.

† A posterior view of the ligaments of the knee-joint. 1. The internal condyle of the femur. 2. The external condyle. 3. The posterior surface of the tibia. 4. The head of the fibula. 5. The tendon of the semi-membranosus muscle cut short. 6. The inferior or descending process of this tendon. 7. The process of the same tendon which passes forwards and inwards beneath the internal lateral ligament. 8. The process which passes upwards and outwards to assist in forming 9. The ligamentum posticum of Winslow. 10. The long external lateral ligament. 11. The posterior superior tibio-fibular ligament.

rilateral ligament principally *arises;* it ascends obliquely from behind the inner condyle of the tibia to the external condyle of the femur; it separates the gastrocnemii and plantaris from the synovial membrane, is also connected to the borders of the semilunar cartilages, and is strengthened by some fibres from the poplitæus and gastrocnemii tendons. The poplitæal vessels are behind it, and a quantity of adipose substance and the synovial membrane are in front of it. The azygos articular vessels perforate it by several foramina. It is made very tense and resisting in extension of the leg; in flexion it is relaxed and drawn a little backwards, and thereby the synovial membrane and the adipose substance are drawn out of the angle of the joint. (*See* p. 318.)

The *internal lateral ligament,* flat, and broader in the centre than at either end, *arises* from the back part of the tuberosity on the inner condyle of the femur, below the insertion of the tendon of the adductor magnus; descends obliquely forwards, is about three inches long, and is *inserted* into the internal condyle of the tibia; it is closely applied to the synovial membrane and to the semilunar cartilage. The tendon of the semi-membranosus, and some articular vessels, separate it near its insertion from the tibia, and it is covered by the aponeurotic expansion of the gracilis, sartorius, and semi-tendinosus, a bursa being interposed.

The *external lateral ligament arises* from the back part of the tuberosity on the external condyle, above the fossa, for the poplitæal tendon; is thick, round, and smooth; descends, inclining backwards, in front of the biceps tendon, and is *inserted* into the outer side of the head of the fibula, the biceps tendon sometimes inclosing it in its bifurcation. In the extended state of the limb it inclines backwards as it descends, and is in a tense condition; in flexion it is vertical and relaxed. This ligament has little or no connection to the synovial membrane, or to the external cartilage, being separated from these by the poplitæus tendon, the articular vessels, and a portion of the biceps tendon. There is sometimes a fibrous fasciculus more deeply seated, which is named *short* or *deep external lateral ligament;* it *arises* from the condyle more posteriorly, and near to the outer head of the gastrocnemius, adheres to the semilunar cartilage, and is *inserted* into the back part of the fibula. A portion of the biceps tendon separates these ligaments.

The external and internal lateral ligaments are situated a little behind the centre of the articulation; hence they are relaxed in flexion, and tense and resisting in extension of the limb; they serve to connect the bones together, to confine the semilunar cartilages in their places, and to prevent any lateral displacement; they also resist rotation of the femur on the tibia inwards, but admit of rotation outwards, whereas they admit of the tibia or the leg rotating inwards, but not outwards. The direction of the ligamentum patellæ, and of the internal and external lateral ligaments, favors rotation of the tibia inwards more than outwards; rotation of the leg, however, in the latter direction, is more extensive, in the semiflexed position, than in the former, on account of the peculiar arrangement of the crucial ligaments. To see the internal ligaments, separate the extensor tendons from the patella, and open the synovial membrane above and behind the latter.

The *synovial membrane* of the knee is the largest membrane of this class in the body. We may trace it through its whole extent, as it presents one continuous surface. Open it by a transverse incision above, and a vertical one on each side of the patella; allow the latter to fall down everted towards the tibia. From the lower extremity of the extensor tendon the membrane passes back to the forepart of the femur, about two inches above the condyles, and a little higher above the outer than the inner. Where the bursa and synovial membrane communicate freely, and form but one membrane, the upper end of the *cul de sac* will be found in the extended state of the limb three inches

above the trochlea; it is then continued over the latter and over the condyles, and covers their sides, although deficient of cartilaginous incrustation; it ascends higher on the internal side of the inner condyle than of the outer; posteriorly it is also continued above the inner to a greater height. From the back part of the femur it is reflected on the head of the gastrocnemii on each side, and on the posterior ligament in the centre, but partly separated from it by fat. From the depression between the condyles, but rather from the external, a fold of this membrane descends obliquely forwards and inwards to the mass of articular fat at the lower and anterior part of the joint; this is termed the ligamentum mucosum. It is also continued from the femur along the crucial ligaments to the head of the tibia. From the lateral parts of the joint it is continued to the upper surface of the semilunar cartilages, turns round their sharp, thin edge to their lower surface, and thence to the upper surface of the tibia, where it meets the reflections which have descended along the crucial ligaments. From the tibia it is continued anteriorly to the mass of soft adeps, which it covers, and where it joins the ligamentum mucosum; it then passes to the posterior and upper part of the ligamentum patellæ; and, lastly, it covers the back part of the patella, at the upper border of which we commenced its description, and lines the vasti muscles at either side, beneath which, particularly the internal, it is much dilated. These lateral dilations or pouches, especially the inner one, are often very conspicuous in articular effusion. As the poplitæal tendon is continued from the outer condyle, a process of this membrane is reflected round three-fourths of it, as far as the head of the fibula, and touches the synovial membrane of the tibio-peronæal articulation. In some instances the synovial membranes of these two articulations, though very generally distinct, communicate.

Fig. 151.*

Fig. 155 †

The internal ligaments in this joint are the alar, mucous, transverse, crucial, and the semilunar cartilages.

The *alar ligaments* are only folds of the synovial membrane, in some measure produced by the displacement and eversion of the patella; they are one

* A vertical section of the knee-joint in its antero-posterior diameter, in order to exhibit the arrangement of the synovial membrane and the position of the ligamentum mucosum. 1. A section of the lower extremity of the femur. 2. The tendon of the extensor muscles of the leg. 3. The pouch of the synovial membrane between the extensor tendons and the front of the lower extremity of the femur. 4. The patella. 5. The ligamentum patellæ. 6. A vertical section of the tibia. 7. A bursa situated between the ligamentum patellæ and tubercle of the tibia. 8. The mass of fat behind the ligamentum patellæ. 9. The synovial membrane passing downwards from the patella over the mass of fat to the tibia, and reflected upwards and backwards to form 10. The ligamentum mucosum or adipose ligament. 11. 11. The cavity of the synovial membrane. 12. The external condyle of the femur. 13. The superior extremity of the anterior crucial ligament. 14. A portion of the external semilunar fibro-cartilage; its section presenting a triangular form. 15. The posterior ligament of the joint. 16. The superior extremity of the fibula.

† The left knee-joint laid open in front; the femur is flexed upon the tibia and the ligamentum patellæ turned down, in order to expose the interior of the articulation. 1. The

on either side of this bone; the internal is the most distinct; they diverge above, and, uniting below, are lost in the fatty mass on either side of the ligamentum mucosum. These folds often present, as also other parts of this membrane, a fringed appearance, like fine epiploic appendices. In some diseases of the joint these become greatly hypertrophied.

The *ligamentum mucosum*, or *adiposum*, is also only a small fold or tubular process of the same membrane, of a conical form, arising broad from the fatty substance behind the ligamentum patellæ; it passes backwards, upwards, and a little outwards, and is inserted into the notch between the condyles; it serves to regulate the position of the adipose mass, to keep it opposite the condyloid notch, and thus to preserve a more even surface.

The *articular adipose mass* is constantly present in this joint. It presents a conical form, the base resting on the forepart of the upper surface of the tibia, above the inferior bursa, and behind the ligamentum patellæ and the point of this bone, in front of the synovial membrane, which is thus pushed upwards and backwards into the joint. From the apex of the mass the mucous fold proceeds to the condyloid notch, thus suspending or retaining the fat towards this space, and thereby filling up and levelling the irregularities of the surrounding surfaces. Towards the back part of the joint, also, as well as superiorly, beneath the extensor tendon, there is a considerable quantity of fat, even in thin and emaciated subjects, attached to the membrane and to the adjacent structures, not, however, projecting into the cavity, as the mass anteriorly and inferiorly.

The *transverse ligament* extends between and is attached to the anterior convex portions of the two semilunar cartilages, and above the fatty substance before alluded to; it serves to retain the adipose mass in its situation, and to prevent its receding into the cavity of the joint; it also in some measure secures the semilunar cartilages in their proper situation.

The *crucial ligaments* are the most important of the interarticular ligaments. They are two strong, shining, twisted, fibrous cords, which pass from the notch in the femur to the median line of the head of the tibia; they are very close to each other about the centre of the joint, but thence they separate, crossing each other as they pass to their respective attachments. When viewed anteriorly or posteriorly, this decussation resembles the letter X; they cross also in the lateral view, and therefore present the X form whether seen laterally or before or behind. The origin of the anterior is behind that of the posterior, and its insertion is before that of the latter; therefore they cross when viewed in profile. And again, the origin of the anterior is external to that of the posterior, while its insertion is internal to that of the latter, therefore they cross also when viewed from before or behind. To see the ligaments distinctly, the patella must be thrown completely down, the ligamentum mucosum divided, also the lateral and posterior ligaments, and the synovial membrane dissected from these fibrous cords; for although they appear within the cavity of the joint they are really without and behind it, and in the latter aspect the membrane can easily be detached from them at its reflections without its cavity being opened.

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lower extremity of the femur covered with cartilage. 2. The external condyle. 3. The internal condyle. 4. The anterior crucial ligament. 5. The posterior crucial ligament. 6. The transverse ligament. 7. Portion of the ligamentum mucosum. 8. The external semilunar fibro-cartilage. 9. The internal semilunar fibro-cartilage. 10. The superior surface of the head of the tibia. 11. The posterior surface of the ligamentum patellæ which has been turned down. 12. The bursa situated between the ligamentum patellæ and the tubercle of the tibia; it has been laid open. 13. A portion of the external lateral ligament of the knee-joint. 14. The anterior superior tibio-fibular ligament. 15. The interosseous membrane of the leg, deficient above for the passage of the anterior tibial artery.

The *anterior horizontal*, or *external crucial ligament, arises* from the inner and posterior part of the external condyle; descends obliquely forwards and inwards, and is *inserted* near the forepart of the head of the tibia, in front of the spine, where it also joins the anterior cornu of the internal semilunar cartilage. The ligament is smaller than the posterior; it is best seen from the front, and when the joint is flexed.

The *posterior, internal*, or *perpendicular crucial ligament, arises* from the outer and forepart of the internal condyle; descends nearly vertically, but inclining backwards, and is *inserted* partly into the external semilunar cartilage, and partly into the depression on the back of the tibia, behind its median spine. This ligament is larger than the anterior; its origin is seen anteriorly behind the ligamentum mucosum; its insertion is broad, and is best seen posteriorly when the joint is extended and the ligament of Winslow and a quantity of fat removed.

The crucial ligaments serve to attach the femur to the tibia; they steady the one bone upon the other, and strengthen the back part of the joint in the same manner as the patella does in front; they also tend to prevent any lateral displacement; they are both made tense, and become more twisted, and therefore more resistant in rotation of the tibia inwards, but are relaxed and somewhat separate in rotation of it outwards. In extension they are both very tense, especially the posterior: in flexion the anterior is so, but in a less degree; in fine, they resist too great rotation inwards, also excessive extension or flexion, but they admit of rotation outwards. The posterior ligament also, by its attachment to the external semilunar cartilage, serves to retain or restore this cartilage to its place, as in rotation of the leg outwards the cartilage is allowed to yield or move backwards. If the crucial ligaments be divided the femur may be detached, and the twisted structure of the former can be seen. The semilunar cartilages and their ligaments may be next examined.

The *semilunar cartilages* are placed upon the articular surfaces of the tibia. The convex margin of each is thick, and connected by its edges to the synovial membrane, and between these to the external ligaments and fascia. This latter aponeurotic attachment has been called the *coronary ligament* of each cartilage. The internal concave margin has a sharp edge, which is free in the cavity of the joint. Each cartilage presents two surfaces; a superior, which is concave and oblique, adapted to the condyles, and an inferior which is nearly flat, and rests upon the head of the tibia. The anterior and posterior extremities of each are fibrous, and fixed to the head of the tibia, before and behind its middle protuberance: these insertions are termed the *oblique ligaments.* The two cartilages are united in front by the transverse ligament. The *external cartilage* is more circular, and more movable than the internal; it covers the greater part of the external cavity of the tibia; its convex border is loosely connected to the edge of the tibia and to the surrounding ligaments; its extremities or cornu approximate, and are inserted into the depressions before and behind the central spine of the tibia. The poplitæus tendon, and its synovial sheath, are contiguous to the convex border posteriorly, and sometimes groove it. To the same border anteriorly the transverse ligament is attached, which passes across to join the internal cartilage. Its anterior cornu sends some fibres to mingle with the anterior crucial ligament; its posterior cornu is not only inserted into the depression on the tibial spine, but is also connected to the posterior crucial ligament by a distinct and strong fasciculus. The *internal* is a segment of an oval figure; its anterior extremity is narrow, and attached to the head of the tibia in front of the spine; it is also connected to the anterior crucial ligament; its posterior extremity is broader, and its cornu is inserted behind the spine and behind the insertion of the external cartilage; its convex border is attached to the internal lateral ligament; its concave edge is very thin, and its upper surface is not so broad

as that of the external cartilage, therefore the internal glenoid cavity of the tibia is larger than the outer. The median line of the tibia presents the insertion of these several parts in the following order from before backwards. First, the anterior cornu of the internal semilunar cartilage; secondly, the insertion of the anterior crucial ligament; thirdly, the anterior cornu of the external cartilage; the insertion of the anterior crucial ligament is intimately connected to the anterior cornua of both cartilages, particularly of the internal; fourthly, the posterior cornu of the external cartilage, only separated from its anterior by a portion of the insertion of the anterior crucial ligament; fifthly, the posterior cornu of the internal cartilage; and, sixthly, the insertion of the posterior crucial ligament. The semilunar cartilages are composed of concentric fibres, longer externally than internally. The central portions appear truly cartilaginous, but the extremities are distinctly fibrous; they serve to deepen the articular surfaces of the tibia, and thus to retain the condyles of the femur; they must also lessen the effects of concussion in the joint, and in the limb generally; the mobility of the external one also favors rotation of the leg and thigh outwards; in the latter motion the outer condyle of the femur glides a little backwards, the condyle of the tibia being bevelled off posteriorly, so that the external cartilage is enabled to accompany the femur, and thus to secure and facilitate its motion.

Fig. 156.*

This joint enjoys flexion and extension in a very perfect manner, and also, when it is semiflexed, a slight degree of rotation. In these motions the patella is nearly fixed, the trochlea of the femur moves behind it, and its distance from the tibia remains almost uniformly the same; it only serves, therefore, to protect the joint in front, and to support the body in the kneeling posture, and may be considered as a sort of sesamoid appendix to the common tendon of the extensor muscles. When the limb is flexed it is prominent, and steadily fixed on the anterior angle of the joint; but when extended it is movable, and sinks a little downwards and backwards, unless elevated by the rectus and vasti muscles. In flexion the glenoid cavities of the tibia, with the semilunar cartilages, come a little forward beneath the femur, and the latter turns on the former in such a manner that its trochlea looks rather upwards instead of forwards; and the condyles, which, during extension, were prominent posteriorly, are now directed downwards, and lodged in the tibial depressions; most of the ligaments of the joint are relaxed, except the anterior or ligamentum patellæ, which is stretched in proportion as the flexion is increased, and thereby the patella is fixed on the fore-part of the joint, and cannot be moved to either side. This motion can be carried to a great extent, even until the calf of the leg meets the back of the thigh, and both form a very acute angle convex forwards. If flexion be forced too far in the dissected joint, the crucial ligaments, particularly the anterior, will become tense and resistant; when the joint is only semiflexed, the leg can be rotated slightly inwards and outwards; the internal condyle of the tibia moving only as on a pivot, while the external glides forwards or backwards; rotation inwards is resisted by the crucial ligaments, which are made tense and more twisted, whereas in rotation outwards their decussation or twisting is rather unfolded. In this state the opposed surfaces of the tibia and femur

* The superior extremities of the tibia and fibula as seen from above. 1. The anterior surface of the tibia. 2. The posterior surface. 3. Part of the anterior crucial ligament. 4. Part of the posterior crucial ligament. 5. The external semilunar fibro-cartilage. 6 The internal semilunar fibro-cartilage. 7. The transverse ligament. 8. 8. Cartilage of incrustation on the head of the tibia. 9. The head of the fibula. 10. Portion of the external lateral ligament of the knee-joint.

can be separated to a considerable distance. The efficiency, therefore, of these ligaments depends on their being retained in a twisted state, and this is secured by the poplitæus muscle, which, in the erect position, has a constant tendency to rotate the femur outwards, and thereby to increase the decussation and tension of the crucial ligaments. The mobility of the external cartilage backwards, and the form of the outer head of the tibia, facilitate rotation outwards, and the principal muscles contribute to it. In extension the tibial cavities glide backwards, and the condyles of the femur also turn in the same direction, and are prominent posteriorly, where they are supported and opposed by the heads of the gastrocnemii. All the ligaments, especially the posterior, crucial, and the ligament of Winslow, are made tense, except the ligamentum patella, which is quite relaxed, and the patella is movable to either side. The strength and tension of the ligaments are so powerful, that it is totally impossible to carry the extension beyond the straight line, or to bend the joint forwards; when the extensor muscles act strongly, they raise the patella into the upper and deepest part of the trochlea, and its upper half is superior to it.

Dislocation of the patella may take place either upwards, inwards, or outwards; the latter is the more frequent form. A dislocation upwards could not occur without rupture of the inferior ligament of the patella, which is so strong that frequently, in violent action of the extensor muscles, the patella itself snaps across before this ligament gives way. When the knee is much bent dislocation in either direction cannot take place; the extent of the articulating surfaces of the femur, and the force with which the patella is pressed in between the condyles, prevent such a displacement. The dislocation outwards is more frequent, probably for the following reason: the rectus femoris descends obliquely inwards; the ligamentum patellæ, which is only a continuation of the extensor tendon, descends obliquely outwards; the tubercle of the tibia is nearly perpendicularly opposite to the inferior spinous process of the ilium; therefore, the extensor muscle and the ligament form an angle convex inwards at the patella, and concave outwards. The position most favorable to this luxation is when the knee is slightly bent and inclined inwards; if, at that time, the extensor muscles act with sudden force, they tend to straighten the angular line just mentioned, and in doing so to jerk the patella of the trochlea to its outer side. When complete luxation of the patella outwards has taken place, the patella rests over the external condyle of the femur, in which place it is fixed by the rectus, crureus, and vasti muscles; hence the necessity for bending the thigh on the pelvis in attempting the reduction, in order to relax these muscles as much as possible. The extent of the synovial membrane permits this displacement to occur without any rupture of it. Dislocation of the patella inwards is more rare, but in other respects is so similar in its nature to the outward luxation that it does not require any notice.

The tibia may be dislocated from the femur in four directions, backwards, forwards, or to either side; the two former, particularly that backwards, may be complete; the latter are incomplete. There is no joint in the body so well supported by ligaments as that of the knee: on the sides we have the lateral ligaments; in front the ligament of the patella and the tendinous insertion of the extensor muscles; behind the posterior ligament of Winslow; and centrally the strong crucial ligaments and the spine of the tibia rising into the condyloid notch. Additional ligamentous bands are also occasionally seen. When the tibia is completely dislocated backwards into the ham, the ligamentous attachments of the patella, either above or below, must give way, and the leg is shortened. The crucial and posterior ligaments are also torn. The flexor muscles of the leg, which are attached to the tibia, will contribute to keep the bone in the luxated position. Complete forward dis-

locations of the tibia have occurred, but they are very rare; in such case all the ligaments of the joint must give way, and the heads of the gastrocnemii and poplitæus muscles would also, probably, suffer.

The semilunar cartilages are sometimes displaced, particularly the internal one; it usually arises from a sudden twist of the knee inwards, and in persons whose knee-joints are distended from frequent injury or chronic rheumatism: but little is known of the true pathology of this injury.

SECTION XXII.

SUPERIOR TIBIO-FIBULAR ARTICULATION.

This is a very plane arthrodia, the surface of the tibia being slightly convex, and looking downwards and outwards. to meet the head of the fibula, which looks upwards and inwards. The tibio-fibular articulations can scarcely admit of any comparison with the radio-ulnar, though analogous to them in position; but little motion occurring in the former, and very free motion in the latter. This articulation is secured by a distinct *synovial membrane*, which, as has been before mentioned, sometimes communicates with that of the knee-joint; there is also a distinct *anterior* and *posterior ligament*, the anterior is the stronger of the two, each composed of strong fibres passing from the tibia obliquely downwards and outwards to the fibula. The external lateral ligament and the tendon of the biceps still further secure this joint, in which the fibula enjoys a very obvious motion forwards, backwards, and a little upwards: these motions, though to a small extent, yet permit the outer ankle, and, of course, the whole foot, to move more freely outwards.

Luxation of the upper head of the fibula is usually the consequence of disease; for the application of a force sufficient to dislocate the bone is much more likely to break it. The action of the biceps flexor, the only muscle inserted into the fibula, could not alone produce this accident. When the head of the fibula is thrown back, the anterior ligament and the accessory fibres from the tendon of the biceps, with the synovial capsule, are ruptured. Boyer mentions a case in which the whole fibula was driven directly upwards in consequence of a dislocation outwards of the ankle.

The shafts of these two bones are connected by the interosseous membrane, which consists of aponeurotic fibres descending obliquely from the tibia to the fibula; there is a large deficiency in it above, for the passage of the anterior tibial vessels; inferiorly it becomes very narrow, as the bones are nearer to each than above; the anterior peroneal vessels pass through it about two inches above the ankle; the tibialis anticus and the extensors of the foot cover it in front, and the flexors behind.

SECTION XXIII.

INFERIOR TIBIO-FIBULAR ARTICULATION.

This articulation is an amphiarthrosis; the inferior extremity of the fibula is convex and received into a depression on the tibia: both surfaces are rough superiorly and covered by cartilage inferiorly, and are connected together by a strong *anterior* and *posterior* ligament, which are each of a triangular form,

the base below attached to the fibula; thence they pass upwards and inwards to be inserted into the tibia. The *anterior* is covered by the peroneus tertius muscle, the aponeurosis of the leg, and the skin, and rests upon the inferior interosseous ligament; its lower border assists in deepening the anterior border of the ankle articulation, and is composed of glistening parallel fasciculi, which are usually divided by bloodvessels into a superior and inferior set. The *posterior* is similar to the anterior in direction, but of less transverse extent, and consists of a superior and inferior portion; the latter runs more transversely across the back of the ankle-joint and is attached to the two malleoli; it assists in deepening the margin of the cavity for the head of the astragalus, and is covered by the long and short peroneal tendons. The synovial membrane is only a small *cul de sac* continued from that of the ankle-joint. Above this is the *interosseous ligament*, composed of short and strong fibres which fasten the bones very closely and firmly together. The anterior and posterior ligaments not only connect the tibia and fibula to each other, but they also strengthen the ankle-joint, and assist in forming the socket for the astragalus; very little motion occurs in this joint, beyond a little yielding of one surface against the other.

SECTION XXIV.

ARTICULATION OF THE ANKLE.

This is the most perfect ginglymoid joint in the body, excepting that between the ulna and humerus. A deep, mortise-like cavity, with an antero-posterior ridge, is formed by the lower surface of the tibia, and by the two malleoli; the latter deepen the cavity considerably at each side; the tibio-fibular ligaments also, particularly the posterior, complete the margins before and behind. The tibia is the principal bone in this cavity; the fibula forms little more than its outer wall; this, however, though narrow, passes down very low, and affords it considerable defence in this aspect. The internal malleolus is not so long or deep, but is broader, and extends more forwards than the outer ankle; hence the foot inclines outwards more freely than inwards. The upper or trochlear surface of the astragalus corresponds to this cavity, is slightly concave from side to side, and very convex from before backwards; its external margin is more elevated than the internal, and the superior articular surface is continuous with the lateral ones, of which the outer is much larger than the inner. This joint is secured by very strong lateral ligaments, and also by a synovial membrane and an anterior ligament. There is no perfect posterior ligament, but the lower border of the posterior tibio-peroneal ligament extends to a variable depth upon this aspect of the joint.

Fig. 157.*

The *internal lateral* or *deltoid ligament* is very dense; it *arises* from the internal malle-

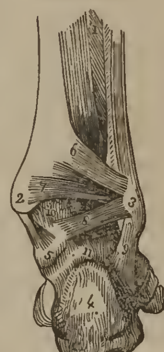
* An internal view of the ankle-joint. 1. The internal malleolus. 2. The os calcis. 3. A part of the astragalus 4. The os naviculare or scaphoid bone. 5. The internal cuneiform bone. 6. The anterior ligament of the ankle-joint. 7. The internal lateral or deltoid ligament. 8. The tendo Achillis. 9. A bursa situated between this tendon and the posterior tuberosity of the os calcis.

olus, descends in a radiated manner, and is *inserted* into the astragalus, os naviculare, and calcis. The superficial and anterior fibres are long and thin and extend to the os calcis and to the calceo-scaphoid ligament. The deeper and posterior fibres are shorter, but much stronger, and often fibro-cartilaginous. In flexion the posterior fibres are tense, in extension the anterior. This ligament is close to the synovial membrane of the joint, and has equally closely connected to it the synovial and tendinous sheaths of the tibialis posticus, and of the flexor tendons which wind around it, and which give additional strength to this region of the joint.

Fig. 158.*

The *external lateral ligaments* are three, a posterior, middle, and anterior. They all *arise* from the external malleolus, and are *inserted* into the astragalus or os calcis. The *posterior* is very strong and tense, and deep-seated; it passes obliquely backwards and inwards to the ridge on the back of the astragalus, which separates the ankle-joint from the articulation of the astragalus to the os calcis, and on the outer edge of the groove for the flexor pollicis longus tendon; its course is nearly horizontal; its superior border is continued some way on the synovial membrane of the ankle to the tibia; it not only secures the ankle articulation, but it also binds the fibula inwards towards the tibia; it is not much altered by the motion of the joint. The *middle* is round and long, like a tendon; descends almost vertically, but a little backwards; and is *inserted* into the os calcis. It is supported by the peroneal tendons; it is made tense in flexion and is relaxed in extension. The *anterior* is short and broad, passes forwards and downwards, and is *inserted* into the upper and outer part of the astragalus. These three ligaments attach the fibula so closely to the tarsus that any violent divellent force can fracture the lower extremity of that bone more easily than separate it from the ankle-joint.

Fig. 159.†



The *anterior* or *tibio-tarsal ligament* of the ankle is thin and membraneous, and often indistinct. It *arises* from the anterior edge of the tibia and tibio-peroneal ligament, and is *inserted* into the upper and outer part of the astragalus; is covered by the tibialis anticus, peroneus tertius, and the extensor tendons of the toes, and by the anterior tibial vessels and nerves, and is separated from the synovial membrane by adipose substance.

The synovial membrane is large and loose before and behind; it always contains some fluid; it lines the articular surface of the tibia and of the two malleoli, and ascends a little way between

* An external view of the ankle-joint. 1. The tibia. 2. The fibula. 3. Its external malleolus. 4. The anterior inferior tibio-fibular ligament. 5. 5. The astragalus. 6. The external surface of the os calcis. 7. The cuboid bone. 8. The os naviculare. 9. The anterior fasciculus of the external lateral ligament. 10. Its middle fasciculus. 11. Its posterior fasciculus. 12. The anterior ligament of the ankle-joint.

† A posterior view of the inferior tibio-fibular and ankle-joints. 1. The lower part of the interosseous membrane. 2. The internal malleolus. 3. The external malleolus. 4. The posterior surface of the os calcis. 5. The posterior part of the astragalus. 6. The posterior inferior tibio-fibular ligament. 7. The posterior transverse ligament. 8. The posterior fasciculus of the external lateral ligament. 9. The middle fasciculus of the external lateral ligament. 10. The synovial membrane of the ankle-joint. 11. The posterior ligament connecting the astragalus and os calcis.

the tibia and fibula. It covers the superior and lateral articular surfaces of the astragalus, and is prolonged a little way on the upper surface of its neck; it is looser anteriorly than in any other direction, to admit of more free extension. Almost the only motions in this joint are flexion and extension; the latter is more free than the former; both can be carried to a considerable extent, but particularly extension; an excess of either motion is resisted by the opposed bony edges coming into contact, and by the tension of the tendons and ligaments. When the joint is flexed, as when we stand in the erect posture, or when it is even more flexed, as when we bend the body forward, there is scarcely any lateral motion whatever; but when the ankle-joint is extended, even to a slight degree, as in walking. the head of the astragalus being locked in the socket, a slight lateral motion can occur to either side, but chiefly to the outer, in consequence of the outer malleolus being on a posterior plane to the internal. In this outward lateral motion the fibula recedes a little, and rises vertically: this latter motion is of great use, and is obvious if the superior articular head of the bone be examined at the time.

This lateral or slight rotatory motion at the ankle-joint is not to be confounded with the general abduction and adduction enjoyed by the different articulations in the tarsus, particularly by that between the astragalus and navicular bones, where even a slight rotation exists. These motions, though different from, yet materially add to that which has been just alluded to in the ankle-joint itself.

The ankle-joint is the frequent seat of injury: the lower extremity of the fibula is very liable to fracture, and the tibia to luxation, complete or incomplete. When any such accidents occur, the foot suffers proportional deformity and displacement. Such displacements ought, in conformity to the language applied to the corresponding injuries in other joints, to be denominated luxations of the foot, whereas writers usually notice the upper bone or bones engaged in the injury. Thus the tibia is described as liable to partial or perfect dislocation inwards, outwards, forwards, and backwards; it might be more correct to describe each of these injuries as perfect or imperfect dislocations of the foot outwards, inwards, backwards, and forwards. When the tibia is luxated *internally*, which is by far the most frequent accident in this region, and which is almost always accompanied with, and indeed in a great measure the consequence of, a fracture of the lower end of the fibula, the internal malleolus projects on the inner side of the astragalus and os calcis, the outer side of the foot and malleolus look upwards, and the sole of the foot is directed somewhat outwards, so that the leg has no longer its proper bearing on the foot, the axis of the former inclining inwards, whilst the foot is twisted outwards; the synovial membrane is ruptured, and in many cases there is laceration of the deltoid and anterior ligaments of the tibia, and of the posterior transverse band from the tibia to the fibula. After the accident has taken place, the contraction of the gastrocnemii, solæi, and especially of the peronæi muscles, which rotate the foot outwards, and draw it upwards, sometimes offer much resistance to reduction: this, however, is usually overcome by placing these muscles in a relaxed position.

If the tibia be dislocated *outwards*, the astragalus is forced outwards below the external malleolus, which latter projects considerably; the foot is turned inwards, the sole looking upwards; and the internal malleolus is sunk in a deep hollow. In this accident the malleolus internus must be broken off obliquely; the deltoid ligament is not ruptured; the fibula is usually broken, but, if not, the external lateral, anterior, and posterior ligaments of this bone are lacerated.

In the dislocation *forwards*, the fibula and malleolus internus are broken; the tibia rests on the anterior part of the astragalus and on the os naviculare; the posterior part of the deltoid ligament, and the transverse band from the

tibia to the fibula, are ruptured. Dislocation forwards is an accident of rare occurrence; it cannot happen when the foot is flexed on the tibia, for then the tibia sinks down on the back part of the astragalus, and nothing but considerable force could raise it over the upper portion of the bone, which, in this position, extends like a bridge before it: it can only occur when the ankle is forcibly and suddenly extended. In this luxation the foot is lengthened behind, and shortened in front, and presents a considerable projection in the latter situation, caused by the tibia and the several tendons it supports.

Luxation *backwards* is even still more rare. Were such an accident to take place, all the tibial ligaments would be broken, and the fibula, most probably, fractured. There is no very accurate account of a well-authenticated case of this accident on record; indeed it is difficult even to conceive how it could possibly occur.—(*See* Todd's Encyc. of Anat., art. "Ankle-joint," by R. Adams.)

SECTION XXV.

ARTICULATIONS OF THE BONES OF THE TARSUS.

The seven bones of the tarsus are connected in such a close and firm manner as to admit of but little motion between any two, except at the articulation between the astragalus and the scaphoid, which is somewhat analogous to that of the os magnum in the carpus.

The *astragalus* rests on the os calcis by two arthrodial surfaces. The posterior articulating surface of the astragalus is concave, external, and larger than the anterior or internal, which is convex: a deep groove, leading forwards and outwards, separates these two joints. These two bones are connected by a strong *interosseous ligament*, which arises from the groove in the astragalus, between the two articular surfaces, and is inserted into that on the os calcis. The fibres run in different directions, and are intermingled with fatty substance. There are also two *synovial membranes*. The *posterior* is confined to these two bones, and larger and looser than the *anterior*, which is continuous with the synovial membrane, between the astragalus and the scaphoid. These synovial membranes are strengthened by strong accessory bands on either side. The lateral ligaments of the ankle-joint also serve to attach these bones more closely, and the tendons of the tibialis posticus and of the long flexors support the connection on the inner side.

Fig. 160.*

The united astragalus and os calcis form the first segment or row of the tarsus, and are connected to the scaphoid and cuboid bones, which form the posterior face of the second row. Between these two rows a considerable degree of motion prevails; and partial amputation of the foot can be performed in this line by separating these articulations.

* The ligaments of the sole, or plantar surface of the foot. 1. The inferior surface of the os calcis. 2. A part of the astragalus. 3. The inferior surface of the scaphoid or navicular bone. 4. The calcaneo-scaphoid ligament. 5. The cuboid bone. 6. The long or superficial fasciculus of the calcaneo-cuboid ligament. 7. 7. The short or deep fasciculus

The anterior end, or the head of the astragalus, is of an oval form, the long axis directed from above downwards, and from without inwards, and is larger than the glenoid surface in the scaphoid bone, below which it projects considerably: this concave surface, together with the strong fibro-cartilaginous calceo-scaphoid ligament and a small portion of the os calcis, complete the socket for the astragalus. This joint approaches to the class of enarthrosis, and possesses very free motion, on which the mobility of the tarsus and toes greatly depends; it is furnished with a synovial membrane, which is covered superiorly by the following ligament; *superior astragalo-scaphoid;* this consists of strong, but short fibres, which extend from the neck of the astragalus to the margin of the scaphoid bone, and are covered by the extensor digitorum brevis. Below this joint is the *inferior calceo-scaphoid ligament,* which extends from the anterior inferior part of the os calcis to the lower surface of the scaphoid. This powerful ligament, or rather fibro-cartilage, supports the head of the astragalus, and is itself much strengthened by the tendon of the tibialis posticus, which winds round beneath it. This tendon also, or this ligament, usually contains a sesamoid tubercle, or a sort of cartilaginous patella, in this place. This ligament supports the great weight of the body, while its elasticity lessens the effects of those concussions to which the limbs are necessarily liable in violent exercise. This joint is also strengthened by another strong ligament, placed superiorly and externally in a deep hollow external to the astragalus, and named *superior calceo-scaphoid.* It extends from the inner and anterior extremity of the os calcis to the outer border and surface of the scaphoid. The synovial membrane of this joint is continuous with that on the anterior and inferior surface of the astragalus.

Simple as well as compound dislocations not unfrequently occur in this articulation, the head of the astragalus being usually thrown forwards so as to form a prominence on the instep. The reduction is in general attended with great difficulty, and occasionally has been found impracticable: in some instances the bone has been completely turned round, so that its lower concave surface has held a firm hold of the end of the tibia.

The *scaphoid bone* is articulated to all the tarsal bones; to the astragalus behind, to the three cuneiform bones before, and to the cuboid externally, and indirectly to the os calcis by the strong inferior calceo-scaphoid ligament just described.

The *cuboid bone* is articulated with the os calcis behind, with the fifth and fourth metatarsal bones before, and internally with the scaphoid and external cuneiform bones. The calceo-cuboid and astragalo-scaphoid articulations are on a transverse level, the line of which is occasionally selected for amputation in disease or injury of the foot or toes. The articular surface of the os calcis is concave from above downwards, whilst that of the cuboid is concave transversely; the joint is strengthened by superior and inferior ligaments. The *superior,* or *dorsal calceo-cuboid ligaments,* consist of broad, but thin and short fibres, which are close to the synovial membrane, and are covered by the tendon of the peroneus tertius.

The *inferior calceo-cuboid ligaments* are very distinct; they are long, thick, and very strong, and can be divided into superficial and deep laminæ, of a bright, shining appearance; they arise from the under surface of the os calcis, pass forwards, and are *inserted* into the cuboid bone, into the sheath for the long peroneal tendon, and into the base of the third and fourth metatarsal bones.

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of the calcaneo-cuboid ligament. 8. Plantar ligaments connecting the other bones of the tarsus. 9. 9. Plantar tarso-metatarsal ligaments. 10. 10. The transverse metatarsal ligament. 11. 11. The lateral ligaments of the metatarso-phalangeal articulations. 12. 12. The lateral ligaments of the phalangeal articulations.

The cuboid is connected to the scaphoid by an *interosseous* substance and by *dorsal* and *plantar scapheo-cuboid ligaments,* whose fibres are transverse and oblique. The two bones, also, usually meet by small articular surfaces covered with cartilage, and furnished with a synovial membrane; the latter, however, is sometimes wanting.

The cuboid is connected to the external, or third cuneiform bone, by dorsal, plantar, and interosseous ligaments, and by a synovial membrane, which is in some cases perfect or distinct; in others it communicates with that between the scaphoid and cuneiform bones.

The anterior surface of the scaphoid presents three articular facettes, for the reception of the posterior ends of the *three cuneiform bones.* These facettes are of a triangular form, the bases of the two external are above, that of the internal is below, and a large synovial membrane is common to these three cuneo-scaphoid articulations, also to those between the cuneiform bones themselves, and to those between the bases of the second and third metatarsal bones and the two external cuneiform bones; it also sometimes communicates with the scapheo-cuboid membrane. The three cuneiform bones are connected to the scaphoid by *dorsal ligaments* and by flat bands, transverse and oblique; also by very strong transverse plantar ligaments, which are strengthened by an expansion from the tibialis posticus tendon.

Dislocations of any of the other articulations of the tarsus are very rare, except in very severe accidents, and where complicated injuries are inflicted on the foot; cases, however, are on record of simple dislocation of the cuboid bone from the os calcis, also of the internal cuneiform bone from the navicular in a direction upwards and inwards.

SECTION XXVI.

TARSO-METATARSAL ARTICUATIONS.

The three internal metatarsal bones are joined to the three cuneiform, and the fourth and fifth metatarsal to the cuboid. The tarso-metatarsal articular range presents a slight waving line from without inwards and forwards; but the second metatarsal bone extends further back than the others. This line is sometimes selected for amputation. But little motion exists in any of these amphiarthrodial articulations; they are furnished with synovial membranes and transverse dorsal and plantar bands. The first metatarsal is articulated to the internal cuneiform bone, and possesses a distinct synovial membrane; the second metatarsal is articulated to the three cuneiform, resting on the middle, and wedged in between the internal and external. The third metatarsal bone is articulated to the third cuneiform; and one synovial membrane, continued from the large cuneo-scaphoid, and from between the cuneiform bones, is common to these two tarso-metatarsal joints. The fourth and fifth metatarsal bones are connected to the cuboid by a common synovial membrane. All these synovial membranes are prolonged between the bases of the metatarsal bones themselves, as in the metacarpus. The tarso-metatarsal range of articulations is secured by strong transverse ligaments, dorsal and plantar, and by interosseous fibres.

The *metatarso-phalangeal articulations* are arthrodial, and furnished with synovial membranes, protected by dorsal, plantar, and lateral ligaments. The *plantar* or inferior are very thick and fibro-cartilaginous, assist in forming the articular cavity in each joint, and are intimately connected to the sheaths for the flexor tendons. These ligaments are connected to each other by strong

transverse fasciculi. The *dorsal ligaments* are weak and thin, but the extensor tendons supply their deficiency. The lateral ligaments are short, strong fasciculi, passing from behind forwards and downwards on each side of this joint. The first or internal metatarso-phalangeal joint is very large and strong, and is rather of the trochlear form; its inferior ligament is very dense and strong, and usually contains two sesamoid bones.

The *phalanges* of all the toes form ginglymoid joints, and are articulated to each other by synovial membranes and by lateral ligaments, as are those of the fingers, and therefore they do not require any elaborate or distinct description.

The phalanges of the toes are but rarely dislocated, either from each other or from the metatarsal bones: the most frequent accident of this is a dislocation of the first phalanx of the great toe from the metatarsal bone.

APPENDIX.

DIRECTIONS FOR MAKING DRIED PREPARATIONS OF THE ARTERIES AND VEINS.

Although in every anatomical school competent persons are retained for the purpose of injecting arteries and veins, still the student may wish to do it for himself, or he may be placed in such situations that he cannot command any kind of assistance; to him more particulary, the few remarks which we purpose making on the method of injecting and of preserving arterial preparations, may be considered applicable.

Injections are of two kinds, coarse and fine; there are many descriptions of coarse injections; with the fine we have nothing to do, as it is used by anatomists only for the purpose of imitating the natural vascularity which membranes and other structures lose after death. Coarse injections may be employed either hot or cold: formerly the hot injection was the only one used, but now the cold one is very frequently employed. As much of the success of the injection depends on the state of the subject, great care should be observed in the choice; if possible a young and thin one should always be employed, as the arteries in old subjects are so often ossified and inelastic, that we can never be certain that they will not burst from the force employed, and extravasate the injection between the muscles and into the different cavities: another objection to the use of old subjects is, that the constant oozing of oily matter from preparations made of them renders them filthy and almost useless, particularly in warm weather; however some old subjects may be filled with the cold (or paint) injection, if care be taken not to use too much force. When the student has made up his mind to employ the hot injection, it may be useful to him to follow a few rules. In the first place, the pipe should be tied so firmly in the opening into the vessel, that there will be no possibility of its slipping out; secondly, the nozzle of the syringe should always be introduced into the pipe for the purpose of exhausting the artery of air or coagulated blood; this being done, the stopcock should be immediately turned; and lastly, particular care should be taken that the syringe, pipe, and stopcock, are free and in good order.

To inject with the hot injection, it is necessary that the subject should be thoroughly heated; this is best done by opening the cavities of the thorax and abdomen, and filling them with water of a temperature that the hand can bear; the body at the same time should be immersed in water of the same temperature, taking care to exclude atmospheric air as much as possible. The process of heating should be carried on until the subject has acquired a temperature resembling the natural heat of the living body. While this is going on, the injection should be particularly attended to, as the materials are very inflammable, and if care be not taken, or much heat be employed, there will be danger of burning the chimney or house; heat, slowly applied,

will melt the injection without any admixture of air, or endangering the loss of color, which strong heat would certainly effect. When the subject and injection are sufficiently heated, the latter should be sucked up twice or thrice, so as to mix it well with the coloring matter, which always falls to the bottom. Before the syringe is introduced into the pipe, it should be held up and the piston pressed till the injection appears, by which any air that may be in the syringe will be permitted to escape. Taking the wings of the pipe into the left hand, the syringe is to be introduced, and the piston is to be pushed down slowly and gradually with the right hand until the syringe is emptied; this action is to be repeated, till we feel resistance made to the further passage of the fluid in the arteries; if, after this resistance is felt, any further force be used, there will be great danger of rupturing the arteries and producing extravasation. As soon as we are satisfied that the body is injected, it should be put in cold water, where it should remain for a few hours. Either of the following hot injections may be used:

Wax, ℥xvi.
Resin, ℥viii.
Turpentine Varnish, ℥viii.
Chinese Vermilion, ℥i.

This makes a very handsome injection, but it is liable to the inconvenience of melting in warm weather, and in this way producing a flattened appearance in bloodvessels. A much cheaper and better injection, for common purposes, than the above, has been employed. It is made of,

Tallow, 2lbs.
Magnesia Usta, ℥ss.
Chinese Vermilion, ℥i.

This possesses all the advantages of the wax injection without any of its inconveniences; it is as transparent nearly as the wax, never melts in the hottest weather, and is not disposed to crack. If this injection be used very hot, an extremity may be injected without having been previously heated; but this should never be done except by persons skilled in the art of injecting.

If we wish to trace the minute branches of arteries and examine their various communications, there are no injections better adapted for common purposes than that of tallow and red lead well mixed and heated, or the *cold paint injection;* if the latter be well thrown in, the minutest arteries, for instance the ciliary, will be injected. It is made of—

White lead, well ground, 2lbs.
Turpentine Varnish, ʒxii.
Drying Oil, ℥vi.

The lead is intimately mixed with the varnish, and then the oil is to be added; they are to be well mixed up together, to the consistence of cream, and in this state it is to be thrown into the arteries; the same precautions, with regard to the exclusion of air from the syringe, and the degree of force to be used, are to be observed in this as well as in the hot injection. Arteries are always injected from the aorta or some other large trunk; while veins are injected differently. In making preparations of veins, it is necessary to inject them from the extreme branches towards the trunks, on account of the direction of the valves; for instance, the veins of the arm are to be injected from a small branch on the back of the hand, and those of the leg and thigh from some branch on the dorsum of the foot. Previously to the injection being made,

it is necessary that the veins should be well washed out with warm water, to remove the coagula of blood which they generally contain. If the veins of the arm are to be injected, an opening should be made in the subclavian vein, to allow the warm water and coagula to pass out; when this has happened, a ligature, previously applied, is to be firmly tied round the vessel, which will prevent the injection from flowing out; the same rule applies to the injection of veins in the lower extremity. The veins of the head and neck are generally injected from the superior longitudinal sinus. It is scarcely necessary to mention that veins are filled with blue fluid, and the arteries with white or red; for the blue injection smalt blue is usually employed. To inject the arteries a transverse cut is to be made in the aorta, as close to its origin from the heart as possible. Care must be taken that the extremity of the pipe does not project so far as to pass into the innominata, or one of the vessels arising from the left side of the arch, as this would give only partial injection. The nozzle of the pipe being carefully inserted into the opening of the vessel, two pieces of twine are to be introduced under the vessel; one of these is to be firmly tied round the artery, this will embrace the nozzle of the pipe; its loose extremities, when the knot is firmly tied, are to be fixed to the wings of the pipe, in order to prevent any chance of its slipping out of the vessel. The other ligature is to remain loose under the vessel, beyond the nozzle of the pipe about one inch. After injection is thrown in, this ligature is also to be firmly tied round the vessel, leaving the pipe clear; the use of it is, that the injection may not return back when the pipe is removed from the aorta. This precaution is more particularly necessary when the paint injection is used. In inserting a pipe into a small artery or vein, some difficulty may arise in the introduction, from the pipe being larger than the calibre of the vessel; in this case the point of a scissors should be introduced into the vessel, and gradual dilatations produced by slowly opening its blades. When the injection has remained sufficiently long to set well in the vessels, dissection may be commenced, and here it is a rule which should be invariably followed, that the dissection be completed in as short a time as is consistent with a proper display of the vessels, for many preparations are lost in consequence of the part first dissected becoming spoiled before the remainder is prepared for drying. Particular care should be taken to remove all the cellular substance from the coats of the vessels; if this be not done, the preparation will always have a dirty appearance. The fatty matter is likewise to be removed, but no muscle is to be taken away or pushed from its situation unless perfectly unavoidable. The student should always remember that the utility of a dried preparation consists in its preserving, as far as possible, the natural relation of parts; on this account, the use of pieces of stick or other substances, to separate the muscles and exhibit the course of the vessels, unless absolutely necessary, is to be condemned. One side of the subject ought to be appropriated to the exhibition of the superficial vessels, the other may be used for the deep-seated. When the dissection is completed, the extremity, or whatever portion of the body it may be, should be hung up in a dry and airy situation (but not exposed to the sun) until the muscles acquire firmness, and no exudation appears on the surface. The preparation, now fit for use, is to be brushed over with copal or mastich varnish, which makes the vessels more distinct, and materially assists in its future preservation.

LAENNEC'S DIVISION OF THE REGIONS OF THE THORAX.

The chest of a healthy person, when slightly struck, ought to yield over its whole extent a clear and distinct sound. The character of the sound derived from percussion is different in the different parts of the chest; on which

account it has been divided by Laennec into fifteen regions, twelve of which are double.

1. *Subclavian Region.*—This includes merely that portion of the chest covered by the clavicle. When struck about the middle or sternal extremity, this bone yields a clear sound, but its humeral extremity gives rather a dull sound. A knowledge of the morbid or natural sounds of the chest in this region is of great importance; for from it are usually derived the first signs of the development of tubercles in the lungs, which are often found in the upper and back part of the left lung, even where they exist in no other part of the chest.

2. *Anterior-superior Region.*—This is bounded by the clavicle above, and by the fourth rib (inclusive) below. The sound, though clear, is somewhat less so than over the sternal end of the clavicle.

3. *Mammary Region.*—This begins below the fourth rib, and terminates with the eighth. In the female, the mammary gland, in the male, the inferior edge of the pectoralis major, prevents this region from yielding as good a sound as the anterior-superior region.

4. *Submammary Region.*—This extends from the eighth to the cartilaginous border of the false ribs. On the right side the sound is often dull, caused by the size of the liver; while on the left, the sound is frequently more clear than natural, which is attributed to the presence of the stomach distended with gas.

Sternal Regions: 5. Superior, 6. Middle, and 7. Inferior. The sound is as clear over the whole extent of the sternum, as on the sternal end of the clavicle. However, the inferior region sometimes yields a duller sound, in consequence of the accumulation of fat about the heart.

8. *Axillary Region.*—This extends from the axilla to the fourth rib inclusive. The sound here is naturally clear.

9. *Lateral Region.*—This is bounded by the fourth rib above, and terminates with the eighth. The sound is always good on the left side; on the right side it is altered frequently by the liver rising higher than usual, and compressing the right lung.

10. *Inferior lateral Region.*—This is bounded above by the eighth rib, and terminates at the border of the false ribs. This region also, on account of the liver, yields often a completely dull sound on the right side, while, on the contrary, the left, for reasons before mentioned, gives a clearer sound than natural, even where there be effusion of fluid into the pleura, or where the inferior portion of the left lung be obstructed.

11. *Acromial Region.*—This is comprehended between the clavicle, the upper edge of the trapezius, the head of the humerus, and the lower part of the neck. The soft parts interposed in this place prevent all sound from percussion.

12. *Upper scapular Region.*—This corresponds to the supraspinous fossa of the scapula, and yields hardly any sound on account of the muscle which fills it. The spine of the scapula, which forms the inferior boundary of this region, sometimes yields a faint sound when the arms are strongly compressed across.

13. *Lower scapular Region.*—This corresponds to the infraspinous portion of the scapula. It yields no sound on percussion, because this portion of the scapula is covered by the infraspinous muscle.

14. *Interscapular Region.*—This includes the space between the dorsal edge of the scapula and the spine, when the arms are crossed on the breast. The muscles of this region necessarily render every sound dull; sometimes, however, in thin persons, it gives a low but distinct sound, if the head be bent and the arms crossed in order to make tense the trapezius and rhomboidei muscles. The spine in this region gives a good sound; as, likewise, that por-

tion of the chest included between the superior dorsal angle of the scapula and the first dorsal vertebra.

15. *Inferior dorsal Region.*—This begins at the level of the inferior angle of the scapula, terminating at the twelfth dorsal vertebra. Percussion of this region should be made in a transverse direction, on the angle of the ribs; in the upper part, the sound is sufficiently good; in the lower it is slight, or often does not exist, especially on the right side, from the presence of the liver; on the left side it frequently gives an unnaturally clear sound, on account of the distended state of the stomach.

OPENING THE CRANIUM, THORAX, AND ABDOMEN.

The operation of opening the cranium with the hammer, as described in a former part of this work, requires less labor and time than that done with a saw, and ought always to be preferred, except in cases where there is a wish to preserve the skull, or in private houses, where the feelings of the relatives are likely to be offended by the noise made with the hammer. When the saw is used, the head is to be placed on a block, the cut is to be carried round in the same direction, and the same precautions observed as described in using the hammer; if much caution be not used, the saw is very likely to lacerate the substance of the brain, owing to the inequality of thickness of the bone. In cases, however, where the head is to be opened for examination into the causes of death, without an intention of pursuing the dissection further, a different mode is generally practised; this is done by making an incision, by the introduction of the point of a knife under the scalp, commencing at one ear, and carried over the vertex to the other; in this way we avoid cutting the hair, which in a female might be troublesome, and the flaps made by the dissection of the scalp, being reflected over the face and neck, prevent those parts from being soiled.

For the purpose of examining the morbid appearances after death in the thorax and abdomen, these cavities are generally opened at the same time; an incision carried down from the top of the sternum, and ending at the symphysis pubis, dividing the integuments, muscles, and peritonæum, will bring the latter cavity into view; next, let the skin and muscles covering the front of the thorax be turned back, which will expose the cartilages connecting the ribs with the sternum; immediately at their point of connection with the bone, the cartilages are to be cut; in doing this some caution is to be used; if not, the viscera will sometimes be wounded by the point of the knife slipping down further than is intended. Holding the knife horizontally between the thumb and the middle finger, while the forefinger is placed on the back of the instrument as a guide, will always obviate this inconvenience.

In some old subjects, where the cartilages of the ribs are in some degree ossified, they will not yield to the knife, and here a saw is to be employed. All the cartilages, except those of the first ribs, being divided, the sternum may now be raised like the lid of a box, and a very convenient hinge is made by cutting the articulation of the first joint of the sternum on the inside, directly opposite the second rib: by following this rule the figure of the thorax will be preserved, after the examination is completed, and a view sufficiently extensive for common purposes be obtained of its contents. The practice of making a crucial incision, for the purpose of examining the contents of the abdomen, should always be condemned, and should never supersede the longitudinal, as a view sufficiently extensive for every purpose is obtained by the latter; while the escape of fluids, and the unsightly appearances of the seams produced by the former method, are entirely prevented.

The urinary and generative organs may be removed from the body for examination through the pelvis; and if the integuments in the perinæum, and some of the external organs, be left uninjured, and the several outlets secured, any portion which is interesting as presenting diseased appearances, or which may be required for more accurate examination, may be removed without the external appearance of the body being much disfigured, and without a protrusion of any of the remaining viscera.

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